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REGIONAL  
HYDROGEOLOGIC INVESTIGATION

Town of Hereford Site  
Berks County, Pennsylvania

August 15, 1988

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## TABLE OF CONTENTS

	<u>PAGE</u>
List of Tables	ii
List of Figures	iii
List of Appendices	iv
 1.0 SUMMARY	 1-1
2.0 INTRODUCTION	2-1
2.1 History of Site Activities	2-1
2.2 Project Area Geology	2-1
2.3 ERT/REAC Hydrogeologic Investigations	2-4
 3.0 METHODS	 3-1
3.1 Well Installation	3-1
3.1.1 Location and Description	3-1
3.1.2 Construction	3-4
3.2 Quality Control/Quality Assurance	3-7
 4.0 RESULTS	 4-1
4.1 Hydrogeological Analyses	4-1
4.1.1 Regional Head Distribution	4-1
4.1.2 Aquifer Parameters	4-7
— 4.1.2.1 Slug Tests	4-8
— 4.1.2.2 Pump Test	4-10
4.1.2.2.1 Antecedent Monitoring	4-12
4.1.2.2.2 Drawdown and Recovery Monitoring	4-12
— 4.1.3 Groundwater Flow Velocity	4-17
4.2 Chemical Sampling and Analyses	4-19
— 4.2.1 Soil Gas Survey	4-19
4.2.2 Groundwater	4-22
4.2.2.1 Historical Data - Residential Wells	4-22
4.2.2.2 ERT/REAC Data - Residential and Monitoring Wells	4-24
4.2.2.3 Time Series Sampling (Pump Test) Data	4-29
 5.0 DISCUSSION	 5-1
List of References	
Appendices	

## LIST OF TABLES

	<u>PAGE</u>
1 Well Construction Details	3-5
2 Survey Data and Measured Water Levels - ERT/REAC Installed Monitoring Wells	4-4
3 Results of Slug Test Analyses	4-9
4 Summary of Aquifer Parameters Derived from Long Term Pump Test	4-16
5 Hereford Township Residential Well Sampling Program: November 9-12, 1987, Trichloroethene Concentrations	4-25
6 Hereford Township Monitor Well Sampling Program: May 9-12, 1988, Volatile Organic Compounds	4-26
7 Hereford Township Residential Well Sampling Program: May 9-10, 1988, Volatile Organic Compounds	4-27

# LIST OF FIGURES

	<u>PAGE</u>
1 Project Location Map	2-2
2 USGS 7.5 Minute Topographic Quadrangle Map of the Project Area	2-3
3 Project Area Geology	2-5
4 ERT/REAC Installed Monitoring Well Locations	3-2
5 Overburden Aquifer Water Table Surface: June 1, 1988	4-2
6 Overburden Aquifer Water Table Surface: July 7, 1988	4-3
7 Bedrock Aquifer Water Table Surface: June 1, 1988	4-5
8 Bedrock Aquifer Water Table Surface: July 7, 1988	4-6
9 Location of Pumping Well and Observation Wells	4-11
10 Antecedent Water Level Monitoring Data: Wells MW-4-OB, MW-4-R 05/20/88 - 12:20 through 05/23/88 - 12:40	4-13
11 Measured Barometric Pressure and Rainfall Data (Allentown, PA) 05/20/88 - 12:00 through 05/23/88 - 24:00	4-14
12 Soil Gas Transects and Sampling Points	4-20
13 Analytical Results of Soil Gas Sampling	4-21
14 Trichloroethene Concentrations Measured at Selected Residential Wells By Region III TAT: 1983-1988	4-23
15 Bedrock Aquifer - TCE (log ppb): May 9-12, 1988	4-28
16 Overburden Aquifer - TCE (log ppb): May 9-12, 1988	4-30

Plate 1 Topographic Survey of Hereford Project Area

Inside  
Back  
Cover

## LIST OF APPENDICES

- A Well Construction Details and Boring Logs
- B QA/QC Analysis of Drilling Water and Fluids
- C Residential Well Data Summary
- D Slug Test Data
- E Pump Test Data
- F Soil Gas Survey: March 10-12, 1988
- G Soil Gas Survey: June 29, 1988
- H Compilation of Region III TAT Residential Well Sampling Results Through Spring, 1988
- I ERT/REAC Well Sampling Program: Volatile Organic Compounds November 9-12, 1987
- J ERT/REAC Well Sampling Program: Volatile Organic Compounds May 9-12, 1988
- K Pump Test Time Series Sampling: 10-1000 min.
- L Pump Test Time Series Sampling: 1440-2880 min.

## 1.0 SUMMARY

The Town of Hereford site refers to an area of soil and regional groundwater contamination within the fractured crystalline highlands and carbonate valley of the municipality of Hereford, located approximately 65 miles northeast of Philadelphia in northeastern Berks County, Pennsylvania. The highland within the project study area is referred to as Blackhead Hill. This hill is heavily wooded and exhibits extremely steep topography to the west and south of its crest. To the northeast, the top of the hill is essentially level, and a working farm (the Crossley Farm) covers much of its area.

ERT/REAC response activities at the site consisted of several phases, including: (1) development of accurate maps of the extensive project area, (2) performance of residential well monitoring and testing program, (3) execution of soil gas surveys, and (4) design and implementation of a monitor well installation and testing program. Phase 2 activities included well depth sounding, water level monitoring, and chemical sampling. The phase 4 scope of work included sediment logging and rock coring, water level monitoring, hydraulic testing, and chemical sampling.

Developed water table surface maps indicate radial flow to the west, southwest, and south from Blackhead Hill in overburden sediments. The same pattern is evidenced within the bedrock aquifer in the vicinity of the highlands; within the carbonate valley, the flow gradient is to the south. Flow velocities in the overburden are estimated to range from 0.04 to 0.28 ft/day depending on the hydraulic gradient. Velocities in the fractured bedrock aquifer system are extremely high, and are estimated at 38 ft/day along the steep gradient between the crest of Blackhead Hill and the valley, and 2.0 ft/day within the valley itself.

The results of the soil gas survey, water level monitoring, and chemical sampling of monitor wells implicate several disturbed areas near the crest of Blackhead Hill as the source of regional trichloroethene (TCE) contamination. Within the overburden, the waste plume extends radially for a maximum distance of about 1700 ft. Within the bedrock, contaminant migration is controlled by the geologic structure. Faults and fractures rapidly channel contaminants downgradient to the carbonate valley west of Blackhead Hill. Within the valley, contaminant migration is presumed to occur in enlarged, weathered zones with the carbonate matrix. The extent of the waste plume in the bedrock aquifer is approximately 8000 ft, from the crest of Blackhead Hill to the lower Dale valley.

The presumed source areas of contamination on Blackhead Hill consist of a borrow pit area and an abandoned quarry. A thin remaining soil cover in the former area, and physical inaccessibility to the latter, precluded direct sediment sampling and analysis. The results of chemical data from the overburden and bedrock monitor wells suggest a deep source of contamination, e.g., emplacement of wastes within the abandoned quarry with direct communication to the fractured aquifer system.

Since there is no apparent shallow (surficial) source of contamination, remedial action at the site would appear to be limited to control of the fracture flow regime at, or immediately downgradient, of the crest of Blackhead Hill. ~~Due to the nature of contamination and the characteristics of the bedrock aquifer, the applicability of in-situ methods of aquifer renovation is limited.~~ Consequently, the effectiveness of surface physical and/or biological treatment of pumped groundwater require additional evaluation.

## 2.0 INTRODUCTION

### 2.1 A History of Site Activities

The Town of Hereford site refers to an area of soil and groundwater contamination located on and around Blackhead Hill in the municipality of Hereford, located approximately 65 miles northeast of Philadelphia in northeastern Berks County, PA (Figures 1 and 2). A working farm (Crossley Farm) comprises much of the land area on top of Blackhead Hill.

Regulatory agency action regarding this site was initiated in 1983 as a result of complaints from residents regarding degraded water quality. At that time, EPA Region III informed the Agency for Toxic Substances and Disease Registry (ATSDR) of this issue. In November 1983, the Pennsylvania Department of Environmental Resources (PADER) and the Roy F. Weston, Inc., Technical Assistance Team (TAT) obtained samples of tap water and found elevated levels of trichloroethylene (TCE) in eight homes in the project area. In six of these homes, TCE concentrations exceeded 200 ppb. The PADER subsequently issued advisories to the public regarding water usage in which they recommended boiling water, installing point-of-use carbon filtration systems, or using bottled water where TCE concentrations exceeded 45 ppb. A temporary water supply was provided by the Pennsylvania National Guard through Pennsylvania Emergency Management Agency (PEMA). This supply was terminated by the National Guard in mid 1985.

In early 1984, the EPA Region III Field Investigation Team (FIT) conducted a site assessment; they could not identify the source of contamination, and suggested that a regional groundwater study be undertaken.

In September 1986, in response to citizens' complaints via the Governor's hotline in August, Region III TAT reassessed the project area. TCE concentrations ranging from 500 to 19,000 ppb were detected in tap water samples collected from residences. Since that time, samples have been taken from a number of homes every three to six months.

In the Spring of 1987, EPA Region III requested technical assistance from EPA/ERT, and EERU/REAC\* initiated field activities in the Summer of 1987.

### 2.2 Project Area Geology

Hereford Township lies on a part of the Reading Prong, a large northeastern-southwest trending highland of Precambrian age

\* The contractor support group for EPA/ERT was referred to as EERU (Environmental Emergency Response Unit) until October 1987. Following a contract reauthorization and contract rebid at that time, the support group was restructured and renamed the Response Engineering and Analytical Contract (REAC).



FIGURE 1  
PROJECT LOCATION MAP

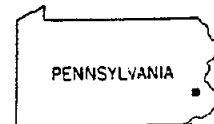
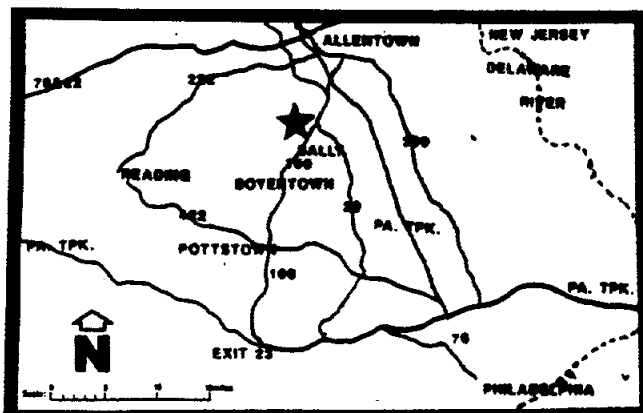
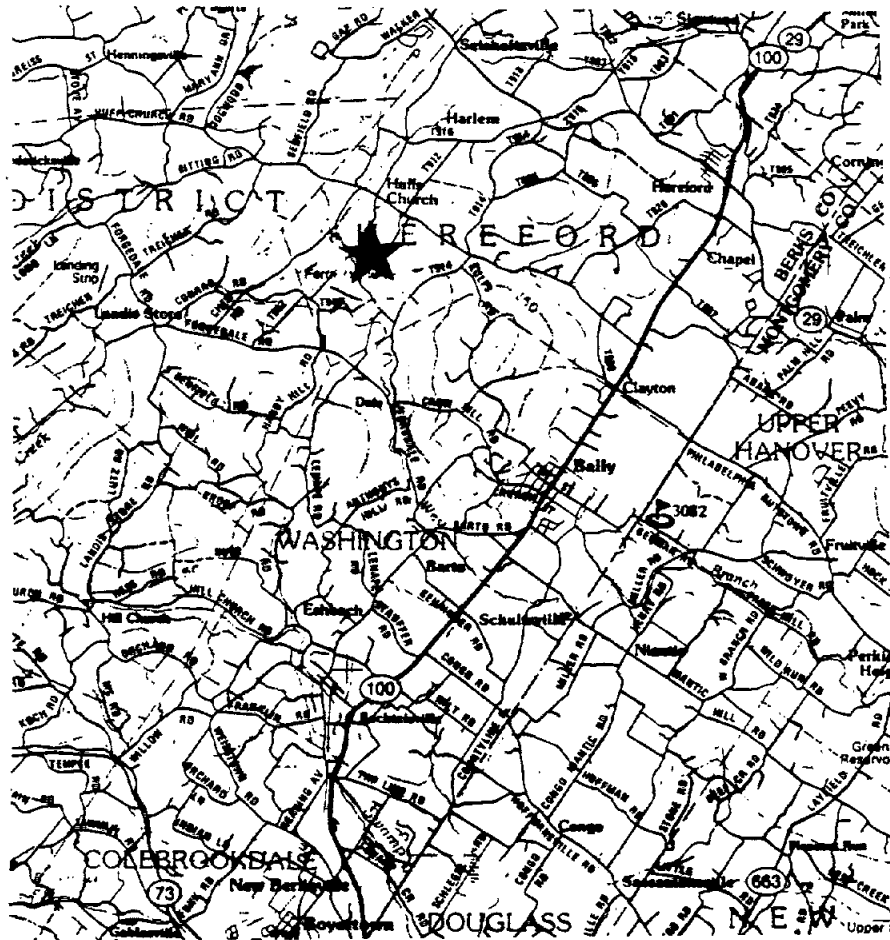
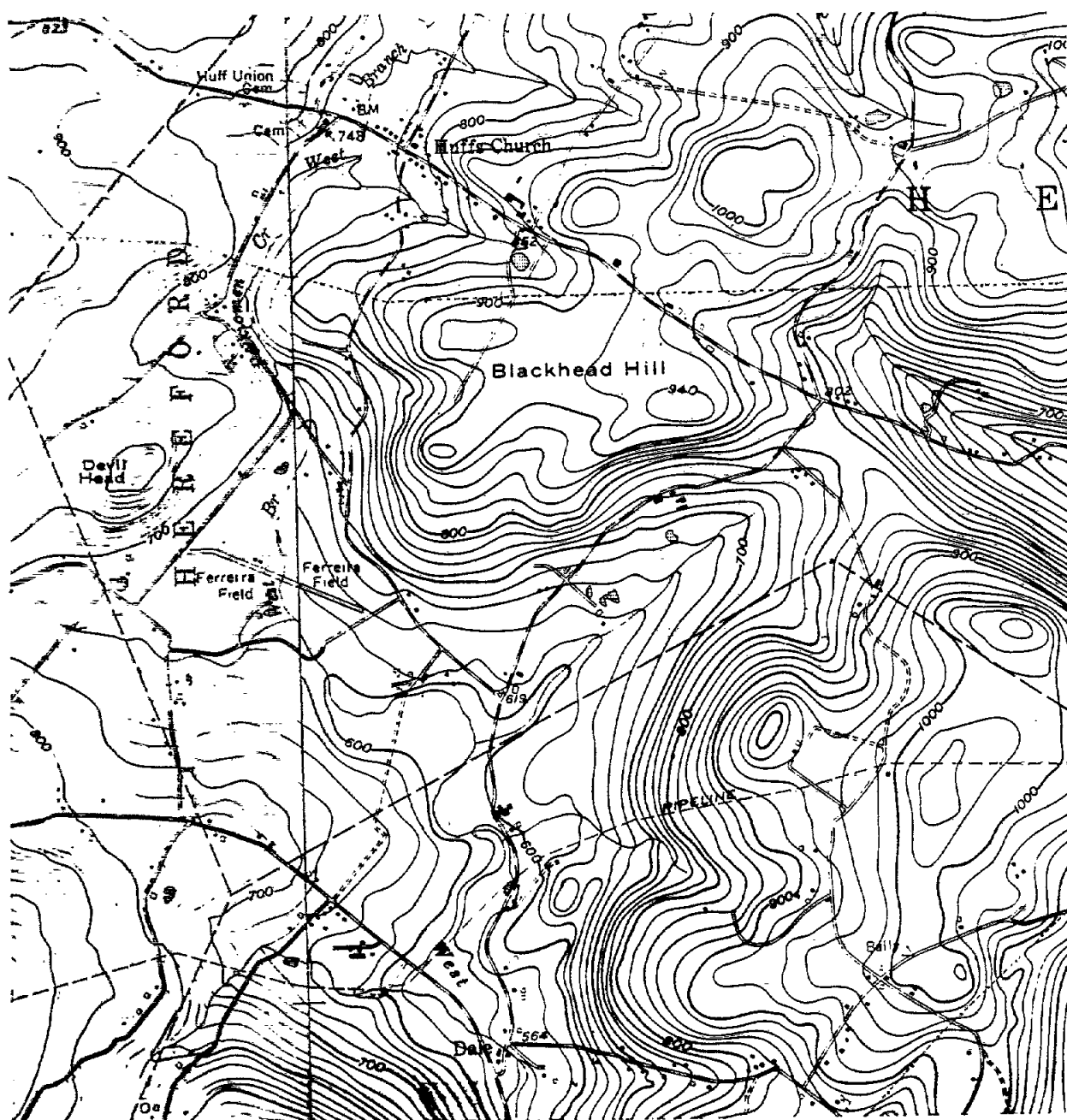


FIGURE 2

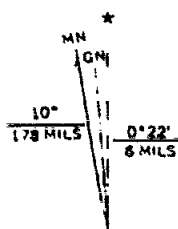
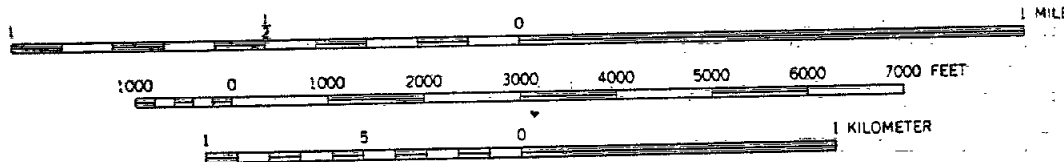
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAP  
OF THE PROJECT AREA



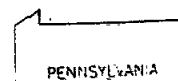
Manatawny, Pa. Quad

SCALE 1:24 000

East Greenville, Pa. Quad



CONTOUR INTERVAL 20 FEET  
NATIONAL GEODETIC VERTICAL DATUM OF 1929



UTM GRID AND 1973 MAGNETIC NORTH  
DECLINATION AT CENTER OF SHEET

crystalline and Paleozoic rocks. This Highland is an extension of the crystalline rocks of New England that trend across southeastern New York State and northern New Jersey into southeastern Pennsylvania. The Highlands are bordered to the north and west by Lower Paleozoic carbonate rocks and shales of the Great Valley Physiographic Province, and to the south and east by Triassic Lowlands.

The project area is situated on Precambrian gneiss, Cambrian quartzite of the Hardyston Formation and Cambro-Ordovician limestone/dolomite (Figure 3). Dale Valley, located to the west and south of Blackhead Hill, is comprised predominantly of dolomite of the Leithsville formation. Bedrock in the project area is overlain by saprolite (weathered parent rock) and alluvial deposits that typically range in thickness from 30 to 120 ft. Several faults are mapped through this area, the most important of which run southwest from the top of Blackhead Hill to Forgeable Road, forming what appears to be a graben of quartzite amidst gneiss. Additionally, a single fault runs from the same area southeast towards Dairy Lane (Buckwalter, 1959).

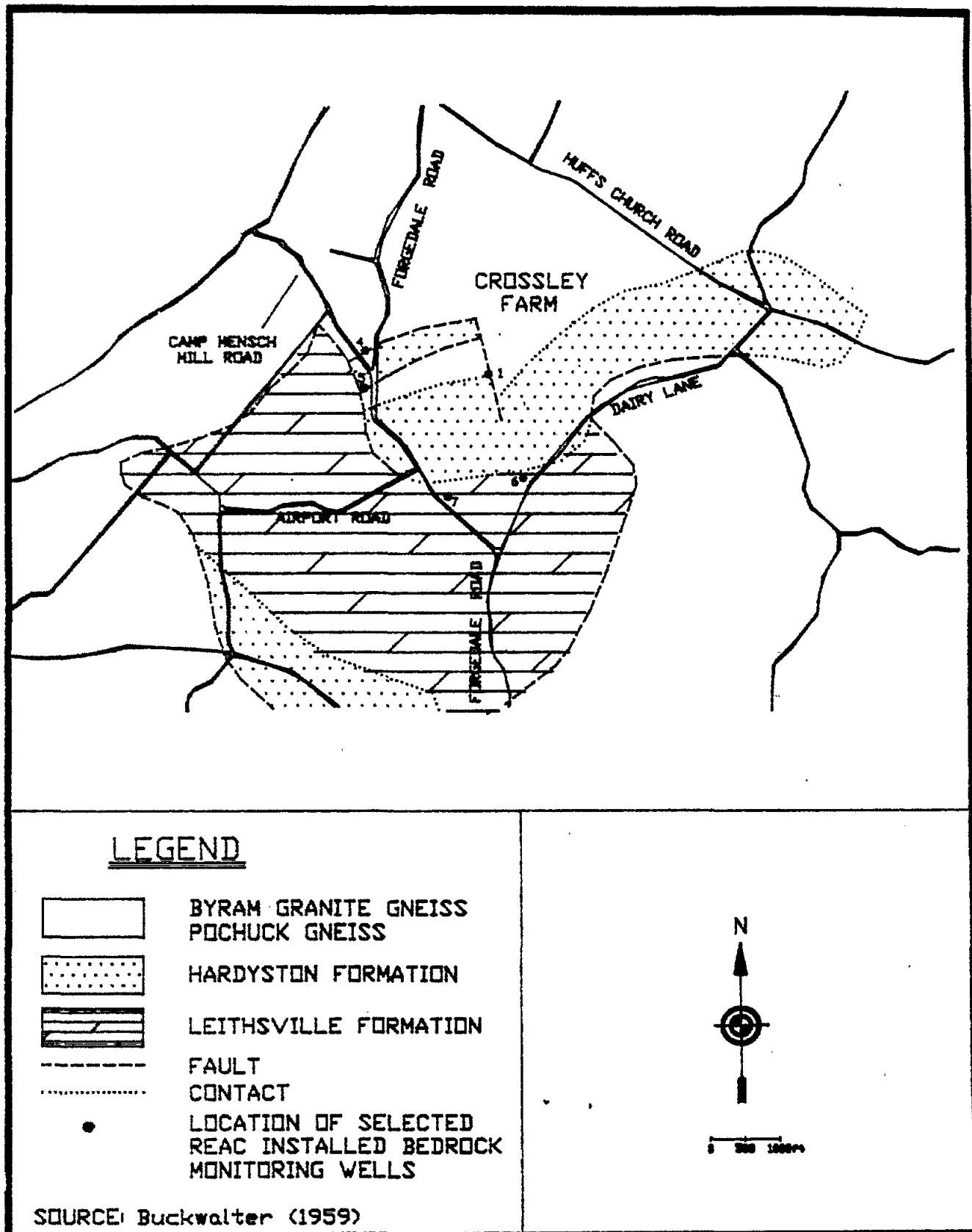
The structural geology of the project area is not completely understood, and a number of hypotheses have been formulated to describe the complex assemblage of mapped Precambrian and Paleozoic rocks. (Such complexity is not unusual in areas bordering the intersection of several physiographic provinces.) The two most prominent hypotheses are: (1) Precambrian crystalline rocks were thrust over a floor of Paleozoic rocks, with the Dale Valley carbonates representing an erosional window through the thrust block, or (2) the exposed Dale Valley carbonates are the result of down faulting and folding of the sediments into a deep syncline, with a later strong shearing of the synclinal structure (Buckwalter, 1962).

### 2.3 ERT/REAC Hydrogeological Investigations

ERT/REAC investigations in support of a regional hydrogeologic assessment were divided into two phases: (1) development of accurate maps of the project area, and (2) design and implementation of a drilling and testing program. Detailed maps of the project area were developed through aerial photography provided by EPA-EPIC, and photogrammetry and surveying provided through REAC subcontract by Quinn Associates of Horsham, PA. Aerial photography was received by ERT in September of 1987, and detailed topographic maps were completed in early October of 1987. In addition to surveying work performed during the Summer of 1987, ERT/REAC personnel performed reconnaissance of residential wells, including water level measurement and depth sounding during June and July.

Plate 1 (oversize map contained inside the back cover of this report) comprises the result of photogrammetry and surveying work performed for this project. A work plan for a regional hydrogeologic study was prepared in October of 1987. The work plan consisted of the following elements: (1) Installation of overburden and bedrock

FIGURE 3  
PROJECT AREA GEOLOGY



monitoring wells, (2) limited chemical sampling of sediments near the presumed source area of contamination, (3) chemical sampling of monitoring wells and residential wells, and (4) hydraulic monitoring and testing of wells to estimate aquifer parameters.

A bid specification for well installation was distributed to four drilling contractors on October 9, 1987, with a bid close date of November 9. Due to the development of equipment problems and revised workload schedules, none of the four contractors elected to bid. The specification was resubmitted to eight different drilling contractors on November 16, 1987, with a bid close date of November 26. The drilling and grouting division of Hydrogroup Inc. (Linden, NJ) was subsequently selected to provide shallow (overburden) drilling services; Hurdis Drilling Company, Inc. (Foster, RI) was selected to provide bedrock drilling, coring, and pump testing services.

Drilling commenced on December 15, 1987, and was completed on May 1, 1988. Severe weather (extreme cold, snow, and mud) throughout much of this period acted to delay the drilling schedule on several occasions. Chemical analysis of sediment core was not possible in suspected source areas of contamination on top of Blackhead Hill (excavated, "borrow pit" area and abandoned (blasted) quarry area) due to thin, rocky soil cover and general inaccessibility by drilling equipment. Instead, an extensive soil gas sampling survey was performed during the week of March 7, 1988. A limited, follow-up survey was also performed on June 29, 1988. Purging and chemical sampling of monitoring wells and residential wells occurred during the week of May 9, 1988. Slug tests were performed on all ERT/REAC installed monitoring wells during the week of May 16, and again in selected wells on June 21, 1988. A long-term (48 hr) pump test was performed in monitoring well 4R during the week of May 23. Vertical and horizontal control at all monitoring wells and selected residential wells was provided in the field by the REAC surveying contractor throughout May and into June 1988. This work was delayed by continuous rain for a two week period in May. Section 4.0 of this report summarizes the pertinent findings of the hydrogeological, soil and groundwater chemistry analyses.

The following individuals from the REAC contract were involved in the execution of the work scope identified above: Stephen Posten, Michael Mulvaney, Quentin Hulm, Frank Fendler, Kenneth Tyson, Brian Brass, Akos Fekete, Howard Syvarth, Susan Jacobowitz, Brian McGarrity, Patricia Donegan, and John Dineen.

### 3.0 METHODS

#### 3.1 Well Installation

##### 3.1.1 Location and Description

A total of 21 monitoring wells at 8 primary and 3 secondary locations (sites) were installed as part of this hydrogeologic investigation (Figure 4). Except for several exceptions discussed below, well clusters (shallow/deep well pairs) were constructed at each site to explore the vertical distribution of contamination, and define vertical hydraulic head gradients. The selection of well installation sites was based on several criteria: (1) investigation of shallow sediments near to the suspected source areas of contamination (borrow pit and abandoned quarry), (2) investigation of the bedrock aquifer along mapped fractures hydraulically downgradient of Blackhead Hill, (3) investigation of groundwater quality in the overburden and bedrock upgradient of the suspected source areas of contamination, and (4) investigation of areas for which there was no data coverage provided by existing residential wells.

A more complete description of each well site location is presented below. Designations used to describe each well in the following discussion, and through the remainder of this report are as follows: OB-overburden well, DOB-deep overburden well, RW-rock well, and DR-deep rock well.

##### Site 1 (MW-1-OB, MW-1-R)

Site 1 is located 700 ft southeast of and topographically downgradient of the borrow pit area, at the intersection of a mapped fault and contact zone between the Precambrian crystallines and the Hardyston formation (Figure 3). Overburden and rock wells were installed at this location to investigate the premise that the borrow pit area represents a source area of contamination. Site 1 was selected to optimize hydraulic investigation of fracture systems to the south of Blackhead Hill, and allow for sampling of the overburden within a reasonable distance of the borrow pit (overburden has been almost entirely removed within the borrow pit itself).

##### Sites 1.1 and 1.2 (MW-1.1-OB, MW-1.2-OB)

Due to the presence of extremely hill, rocky, and forested terrain in the immediate vicinity of the abandoned quarry, it was originally felt that well installation would not be feasible in that area. However, through use of a small, track mounted auger rig, two shallow overburden wells were successfully installed topographically downgradient of the quarry. Well 1.2 is located 300 ft to the northeast of the quarry, and Well 1.1 is located 300 ft to the north. The purpose of these wells, like those at Site 1, was to investigate the premise that the abandoned quarry represents a source area of contamination.

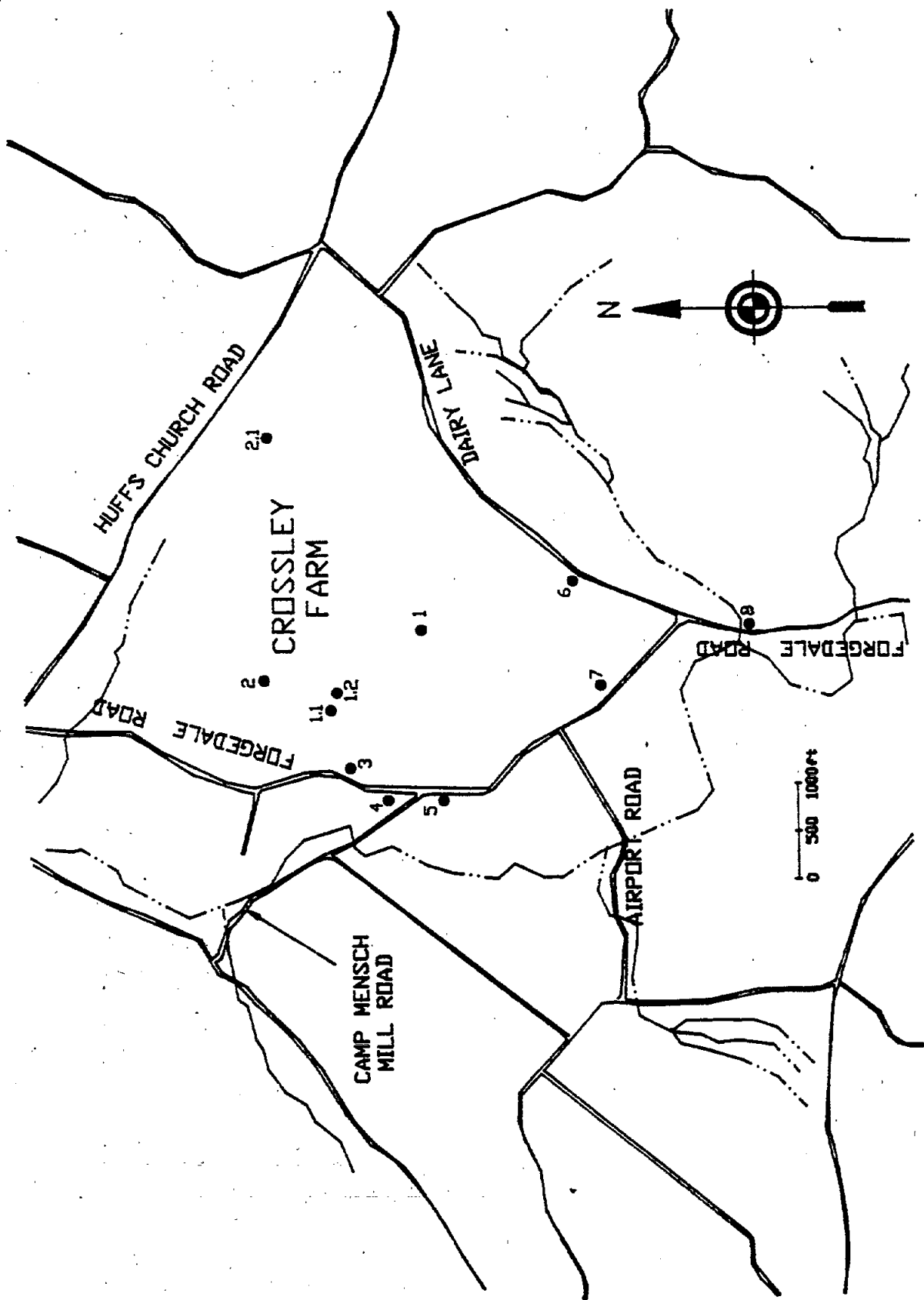


FIGURE 4  
ERT/REAC INSTALLED MONITOR WELL LOCATIONS

#### Site 2 (MW-2-OB, MW-2-R, MW-2-DR)

This site is located approximately 1000 ft north-northeast of the abandoned quarry area. The wells at this location were designed to investigate upgradient or background groundwater quality conditions. Due to the fact that a very productive shallow fracture zone was encountered during the drilling of MW-2-R, a deeper rock well was also installed. MW-2-OB was originally located approximately 50 ft north (topographically upslope) of its present location. However, due to the fact that the well was chronically dry, and a property owner request to move the well closer to the adjacent tree line, the current MW-2-OB was installed, and the original well was removed and grouted. The current overburden well also experiences periods of no standing water.

#### Site 2.1 (MW-2.1-OB)

As part of a soil gas survey performed across the Crossley Farm (report Section 4.2.1), headspace samples were analyzed from a number of monitoring wells. GC (Photovac) data from well 2OB indicated the presence of TCE (Appendix F). Since this location was intended to represent an upgradient (uncontaminated) site, a new location was selected to provide background groundwater quality data for the overburden aquifer. Well 2.1, located 2850 ft east-northeast of the crest of Blackhead Hill, was constructed to serve this purpose.

#### Site 3 (MS-3-OB, MW-3-DOB)

Site 3 is located along Forgedale Road at the foot of a steep slope approximately 700 ft west of the abandoned quarry. This site represents the closest access point to the quarry for heavy equipment from the valley area below Blackhead Hill. Shallow and deep overburden wells were installed at this location to investigate the vertical distribution of contamination in sediments steeply downgradient of the suspected quarry source area. Access constraints at this location precluded use of a large rotary rig for rock well installation.

#### Site 4 (MW-4-OB, MW-4-R)

Site 4 is located between Forgedale and Camp Mensch Mill Roads, about 1200 ft west and downslope of the crest of Blackhead Hill. The site lies on a mapped fault that runs from the top of Blackhead Hill (Figure 3) and is presumed to intersect the Wetzel Well (R41) in which the highest recorded TCE concentrations in the project area were recorded. This particular site location was considered to represent an optimal location for the performance of a long term pump test, due to the presence of several residential wells in close proximity to and surrounding the site that could be used as observation wells.



#### Site 5 (MW-5-OB, MW-5-DOB, MW-5-R)

Site 5 is located approximately 1300 ft downslope and southwest of the crest of Blackhead Hill adjacent to Forgedale Road. This site is located over a second mapped fault trending down from Blackhead Hill (Figure 3) near its intersection with a contact between the Hardyston Formation (quartzite) and the Leithsville Formation (dolomite). Due to the depth of sediment in this area (>100 ft), both shallow and deep overburden wells were installed.

#### Site 6 (MW-6-OB, MW-6-R)

This site is located adjacent to Dairy Lane about 2400 ft southeast of the crest of Blackhead Hill. It is situated along an extension of a mapped fracture trending southeast from the crest of Blackhead Hill (Figure 3). This site was selected to investigate low levels of contaminant concentrations noted along Dairy Lane to the south of Blackhead Hill.

#### Site 7 (MW-7-OB, MW-7-R, MW-7-DR)

This site is located adjacent to Forgedale Road, approximately 2350 ft south of the crest of Blackhead Hill, and about 500 ft south of Airport Road. It is situated in the valley dolomite, near a contact with the Hardyston quartzite. This site was selected to investigate contaminant migration in solution channels in the Leithsville Formation. The site was originally planned to be located adjacent to Airport Road near its intersection with the Perkiomen Creek, in order to investigate vertical head distribution near the regional groundwater discharge area. However, difficulties in obtaining an acceptable access agreement with the local property owner precluded well installation in that area.

#### Site 8 (MW-8-R)

Site 8 is located about 3900 ft south of the crest of Blackhead Hill, adjacent to Forgedale Road. This well was installed primarily to confirm contaminant migration south of the Forgedale Road-Dairy Lane intersection (elevated contaminant concentrations had previously been noted at the Debbern residential well (R 12), as a result of ERT/REAC recommendations to expand the scope of residential well testing to the south).

### 3.1.2 Construction

Well construction details of all wells, and stratigraphic logs of materials encountered during drilling are contained in Appendix A. The following section provides general information regarding the construction of all wells. Table 1 presents a summary of pertinent well construction details.

TABLE 1  
WELL CONSTRUCTION DETAILS

WELL	TOP OF CASING ELEVATION (msl)	CASING STICKUP (ft)	WELL DEPTH (ft) [a]	LENGTH OF SCREEN OR OPEN BOREHOLE (ft)	SCREEN OR OPEN BOREHOLE ZONE ----- (ft) [a] (msl)	
MW-1-OB	849.77	2.73	56	10	46-56	804-794
MW-1-R	849.34	2.73	162	8	154-162	695-687
MW-1.1-OB	847.60	2.50	41	10	31-41	817-807
MW-1.2-OB	882.99	2.62	44	10	34-44	849-839
MW-2-OB	891.71	1.92	25	10	15-25	877-867
MW-2-R	892.19	2.60	50	18	32-50	860-842
MW-2-DR	890.88	1.25	305	249	56-305	835-586
MW-2.1-OB	933.83	2.25	60	10	50-60	884-874
MW-3-OB	701.73	2.13	23	10	13-23	689-679
MW-3-DOB	706.81	2.58	70	20	50-70	657-637
MW-4-OB	682.21	2.23	21	10	11-21	671-661
MW-4-R	680.55	2.04	237	11	226-237	455-444
MW-5-OB	688.94	2.08	32	10	22-32	667-657
MW-5-DOB	689.20	2.08	103	20	83-103	606-586
MW-5-R	687.93	1.92	302	104	198-302	490-386
MW-6-OB	646.39	1.75	41	10	31-41	615-605
MW-6-R	646.29	1.79	101	6	95-101	551-545
MW-7-OB	645.12	2.48	56	20	36-56	609-589
MW-7-R	644.18	1.96	95	37	58-95	586-549
MW-7-DR	643.57	1.14	123	15	108-123	536-521
MW-8-R	599.64	1.39	123	45	78-123	522-477

[a] Feet below ground surface.

Overburden wells were drilled using either a Mobile Drilling Co., Inc. B-80 auger rig (MW-1-OB, 3-OB, 3-DOB, 4-OB, 5-OB, 6-OB, 7-OB), a mobile B-61 HD auger rig (MW-2-OB, MW-2.1OB), or a track mounted CME, "Bombadier" auger rig (MW-1.1-OB, MW-1.2-OB). In all cases, 7 3/4-in OD hollow stem augers were used to advance the boring until refusal, or until a target depth was reached (Wells 3-OB and 5-OB were screened across the water table).

Wells were constructed with 4-in PVC casing and 0.010-in slot size screen. Screen lengths were limited to 10 ft in all wells except 3-DOB, 5-DOB, and 7-OB in which 20 ft lengths were used. Cape May #1 quartz sand was installed in the annulus as a filter pack to a level about 3 ft above the well screen. One to two feet of bentonite pellets were installed as a seal above the filter pack. Cement-bentonite grout was installed above the pellets to the surface to seal the remaining annular space. Where the filter pack was installed above the water table, the bentonite pellets were wetted and allowed to swell before the cement-bentonite mix was installed. A 6-in protective steel casing with a locking cap was installed within a concrete apron around each PVC stickup.

Bedrock wells were drilled using a Gardner-Denver rotary/pneumatic rig. The overburden was penetrated using a 14 1/4-in tricone roller bit, with air and potable water used as drilling fluids. The large bit size was necessitated due to the nature and thickness of sediments encountered in the project area (initial drilling with a 9 7/8-in bit led to several instances of hole collapse).

Subsequent to reaching competent rock, 6-in steel surface casing was installed in the borehole. The annular space was sealed, and the bottom of the borehole plugged with cement/bentonite grout using the modified Halliburton method (i.e., grout poured inside the casing and allowed to rush up the annulus under pressure). The grout was allowed to setup for a period of 24 hours prior to completion of drilling through the cement plug. Rock drilling was performed using a 5 7/8-in air hammer ("downhole hammer") bit.

Where deep rock wells were drilled adjacent to shallow holes (Sites 2 and 7), casing was installed and grout-plugged to a depth at least 10 ft below the bottom of the shallow hole. At these sites, the 6 in air hammer hole was reamed with a 9 7/8 in tricone bit to accept the 6 in steel casing at depth, and allow for proper sealing of the annulus. During the construction of Well 7-DR, a heavy rainfall resulted in the sloughing of sediments off the inside wall of the overburden borehole subsequent to the installation of 6-in casing. This necessitated pouring approximately 7 yd<sup>3</sup> of stiff, gravel mix cement into the enlarged annulus in order to properly seal the casing against the borehole.

NX rock core was obtained at Sites 1 and 7 using the CME and Mobile B-61 auger rigs, respectively. At Site 1, 190 ft of core was recovered; 203 ft of core was obtained at Site 7. At Site 4, 144 ft of sediment core was obtained without intercepting bedrock (auger

refusal at 22 ft during the construction of MW-4-OB had initially suggested the presence of bedrock at that depth). All core holes were plugged with cement-bentonite grout subsequent to pulling the spin pipe and core barrels.

### 3.2 Quality Control/Quality Assurance

The well installation program was designed to limit the potential for vertical cross contamination between aquifers. Overburden wells were constructed with limited screen lengths (10-20 ft) to investigate specific target zones, i.e., the overburden/rock interface or the vadose zone/saturated zone interface. The depth and number of rock wells at any location was based on the field identification of productive fracture zones. The depth of the rock wells was constrained by the overall guideline that no well should be deeper than the majority of residential wells in the local area. As noted earlier, rock wells were cased from five to ten feet into competent rock, grouted, and allowed to setup overnight. Drilling then proceeded through the grout plug until a productive (i.e., 2 gpm +) fracture zone was encountered. If this depth was significantly less than the indicated maximum depth, a second well was constructed adjacent to it. The latter well was cased to a depth at least 10 feet below the completed first well, grouted and allowed to setup overnight before continued drilling. This procedure acts to maximize the scope of exploratory drilling, while minimizing the risk of accidental contamination of clean water bearing formations or zones.

During the well construction phase, PVC and steel well casing and screen was steam cleaned by the drilling contractor under the supervision of REAC personnel, prior to installation in each well. In addition, the rear portion of each rig, augers, bits, and drill pipe was steam cleaned prior to setup at each new well site. All steam cleaning was performed in a central location away from the well installation sites (the borrow pit near the crest of Blackhead Hill).

As part of the well installation QA/QC process, water samples from the drilling water supply source (Town of Hereford fire hydrant) and the two tanks on the water supply truck were sampled and analyzed for priority pollutant volatile organic compounds (VOCs). The results of these analyses (Appendix B) indicate that the drilling water was free of VOC content. Due to the fact that line breakage and fitting leaks results in spillage of small quantities of hydraulic oil from the Gardner-Denver rig on several occasions, a sample of hydraulic oil was also collected and analyzed for VOCs. This analysis (Appendix B) indicates that toluene represents the only volatile organic compound present in the oil. Finally, subsequent to construction of Well 2.1-OB (but prior to well development or purging), a clear, floating layer was identified on the standing water in the well casing. This substance was analyzed for oil and grease (Appendix B), but no contaminants were detected. It is postulated that this substance may have been a breakdown product of the vegetable oil used by the driller to lubricate the screw fittings on the hollow stem augers.

A number of procedures were followed to allow for the collection of representative aquifer samples during the chemical monitoring phase of the study. Well sampling was performed with stainless steel or PTFE bailers cleaned according to ERT-REAC SOPs at the laboratory and wrapped in foil prior to field use.

In general, a minimum of three casing volumes of water was evacuated from each well, and the well allowed to recover, prior to sample collection. Exceptions to this procedure occurred in several wells where yields were very low. In these cases, the well was pumped dry and allowed to recover prior to sampling. In the overburden wells, purging was accomplished with either a surface (suction) screw pump or bailer depending on yield. In the bedrock wells, purging was accomplished through the use of several submersible pumps. In both overburden and rock wells, lengths of inexpensive (100 psi) PVC tubing were dedicated to each well for sampling purposes. This procedure prevents the possibility of cross-contamination between wells during the purging process.

## 4.0 RESULTS

### 4.1 Hydrogeological Analyses

#### 4.1.1 Regional Head Distribution

Water level measurements were obtained from selected residential wells and ERT/REAC installed monitoring wells on several occasions through the period of performance of this project. The most comprehensive surveys were obtained on June 1 and July 7, 1988. These data were combined with the results of vertical control surveys performed by the REAC surveying subcontractor to generate a series of water table surface or potentiometric surface (hydraulic head) maps. The purpose of these maps is to indicate the general direction of groundwater movement within the aquifer intercepted by the well sampling points. While useful on a regional scale, the head distribution plots must be used with caution across small areas, due to the influence of vertical flow components, and fracture controls on groundwater movement in bedrock.

The water level measurement dates of June 1 and July 7, 1988 were selected to illustrate the effects of seasonal recharge and drought conditions of the aquifer systems. Heavy rain during the spring of 1988, and notably through the last half of May, are reflected in the June 1 data; an extensive dry period occurred between June and mid-July.

Figures 5 and 6 indicate the idealized water table surface in the overburden aquifer within a distance of several thousand feet around the crest of Blackhead Hill. The dashed contours are superimposed over the area's road network (refer to Figure 4 or Plate 1). Water level data from ERT/REAC installed monitoring wells used in constructing these maps are contained in Table 2. This table also indicates horizontal and vertical control data obtained during the surveying phase. Water level data from residential wells used in constructing these maps are contained in Appendix C (residential well data summary). Only those residential wells clearly screened within the shallow overburden (R1, R3, R21, and R27) were included in the generation of Figures 5 and 6.

As expected, the water table gradient in the overburden aquifer trends steeply down the slope of Blackhead Hill to the south and west. The gradient is much gentler to the north and east, corresponding to the plateau-like topography atop the hill. Variation in water levels in the overburden wells between the wet and dry sampling periods range from <1 to 10 ft., with an average of about 4.5 ft. As indicated by comparison between Figures 5 and 6, these variations do not act to modify the trend of lateral groundwater flow as represented by the regional gradients.

Figure 7 and 8 illustrate the inferred regional head surface of the area's bedrock aquifers within a distance of about 1 mile around the crest of Blackhead Hill. The accuracy of these maps diminish

FIGURE 5

OVERBURDEN AQUIFER WATER TABLE SURFACE: JUNE 1, 1988

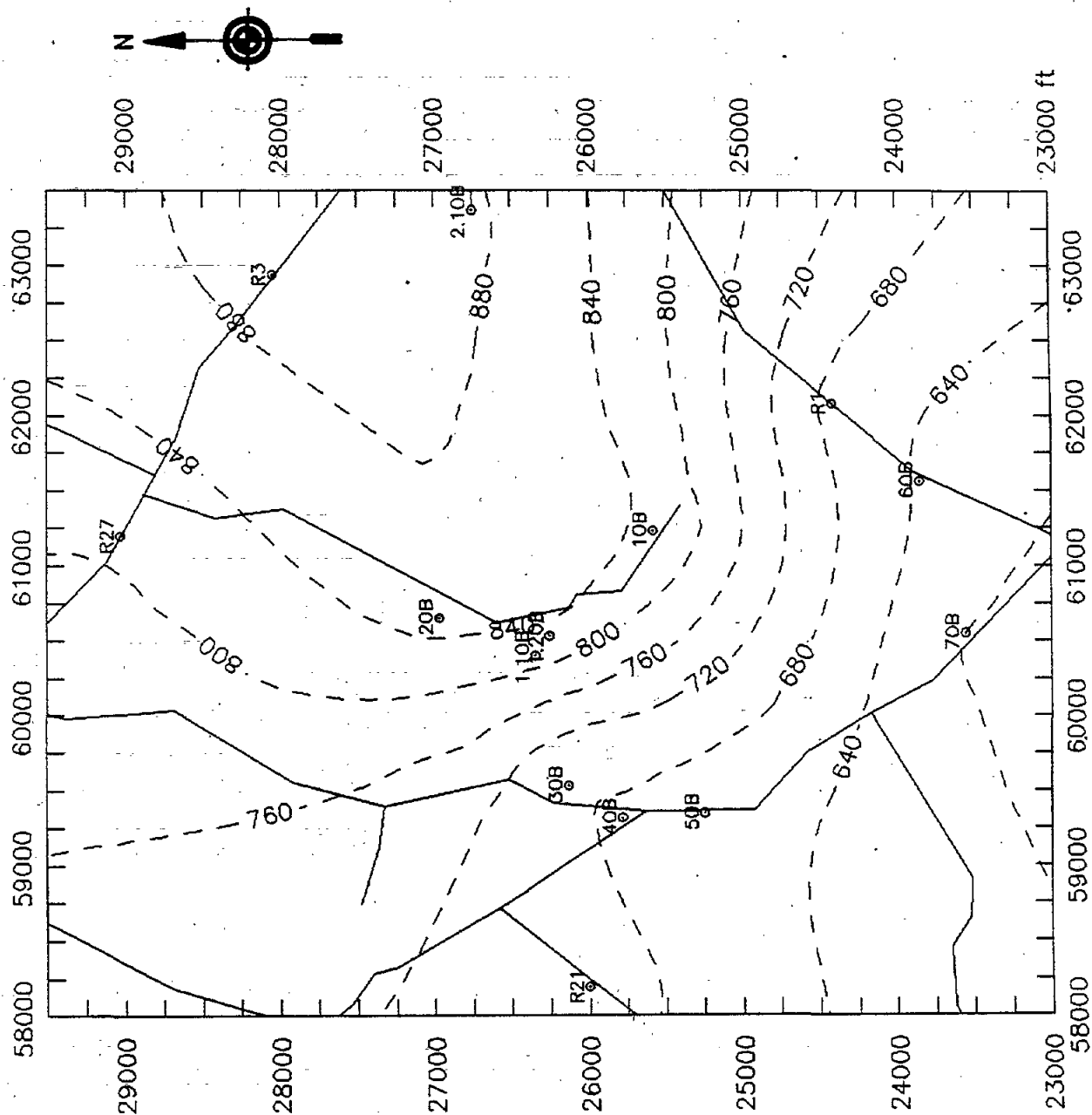


FIGURE 6

OVERBURDEN AQUIFER WATER TABLE SURFACE: JULY 7, 1988

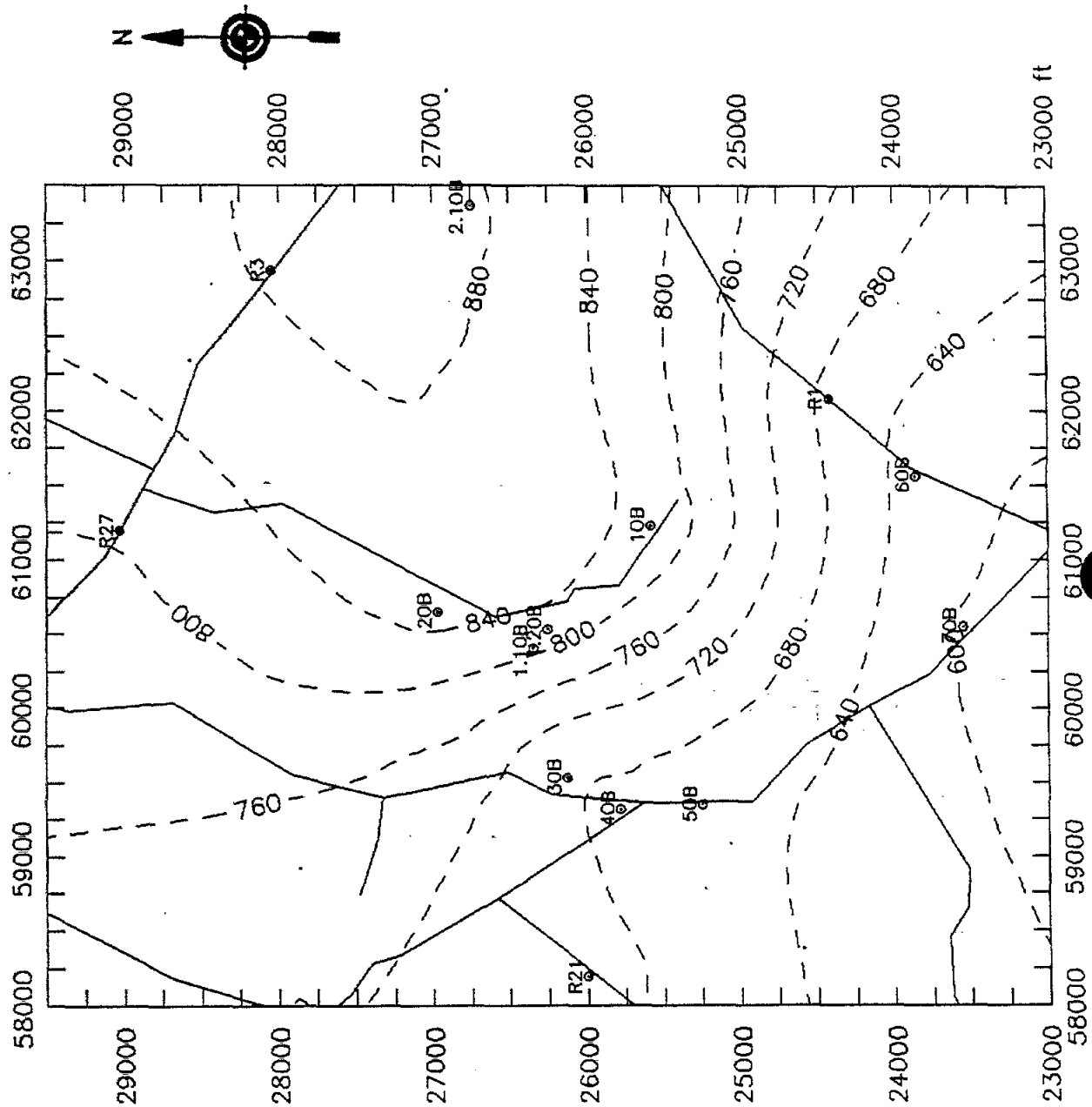




TABLE 2  
SURVEY DATA AND MEASURED WATER LEVELS  
ERT/REAC INSTALLED MONITORING WELLS

	JUNE 1, 1988				JULY 7, 1988		
	TOP OF CASING		ELEVATION (msl)	DEPTH TO WATER (ft)	WATER LEVEL (msl)	DEPTH TO WATER (ft)	WATER LEVEL (msl)
	EASTING (ft) [a]	NORTHING (ft) [a]					
MW-1-OB	61268	25435	849.77	22.08	827.69	27.84	821.93
MW-1-R	61261	25436	849.34	29.12	820.22	35.00	814.34
MW-1.1-OB	60457	26344	847.60	27.43	820.17	35.68	811.92
MW-1.2-OB	60618	26254	882.99	34.85	848.14	43.22	839.77
MW-2-OB	60745	26967	891.71	25.82	865.89	DRY	867.00 [b]
MW-2-R	60738	26970	892.19	28.66	863.53	30.00	862.19
MW-2-DR	60733	26966	890.88	22.65	868.23	26.38	864.50
MW-2.1-OB	63368	26747	933.83	45.32	888.51	44.61	889.22
MW-3-OB	59678	26128	701.73	18.50	683.23	20.55	681.18
MW-3-DOB	59730	26133	706.81	33.91	672.90	37.34	669.47
MW-4-OB	59442	25691	682.21	5.61	676.60	7.50	674.71
MW-4-R	59454	25664	680.55	57.72	622.83	62.22	618.33
MW-5-OB	59516	25246	688.94	23.07	665.87	27.78	661.16
MW-5-DOB	59514	25249	689.20	53.34	635.86	57.79	631.41
MW-5-R	59501	25250	687.93	34.56	653.37	42.45	645.48
MW-6-OB	61662	23765	646.39	14.76	631.63	25.82	620.57
MW-6-R	61673	23749	646.29	49.26	597.03	53.17	593.12
MW-7-OB	60460	23552	645.12	48.38	596.74	51.80	593.32
MW-7-R	60464	23559	644.18	48.11	596.07	52.22	591.96
MW-7-DR	60466	23572	643.57	47.48	596.09	51.74	591.83
MW-8-R	61075	22017	599.64	13.82	585.82	16.19	583.45

[a] Pennsylvania State coordinate system.

[b] Bottom of well elevation.

FIGURE 7

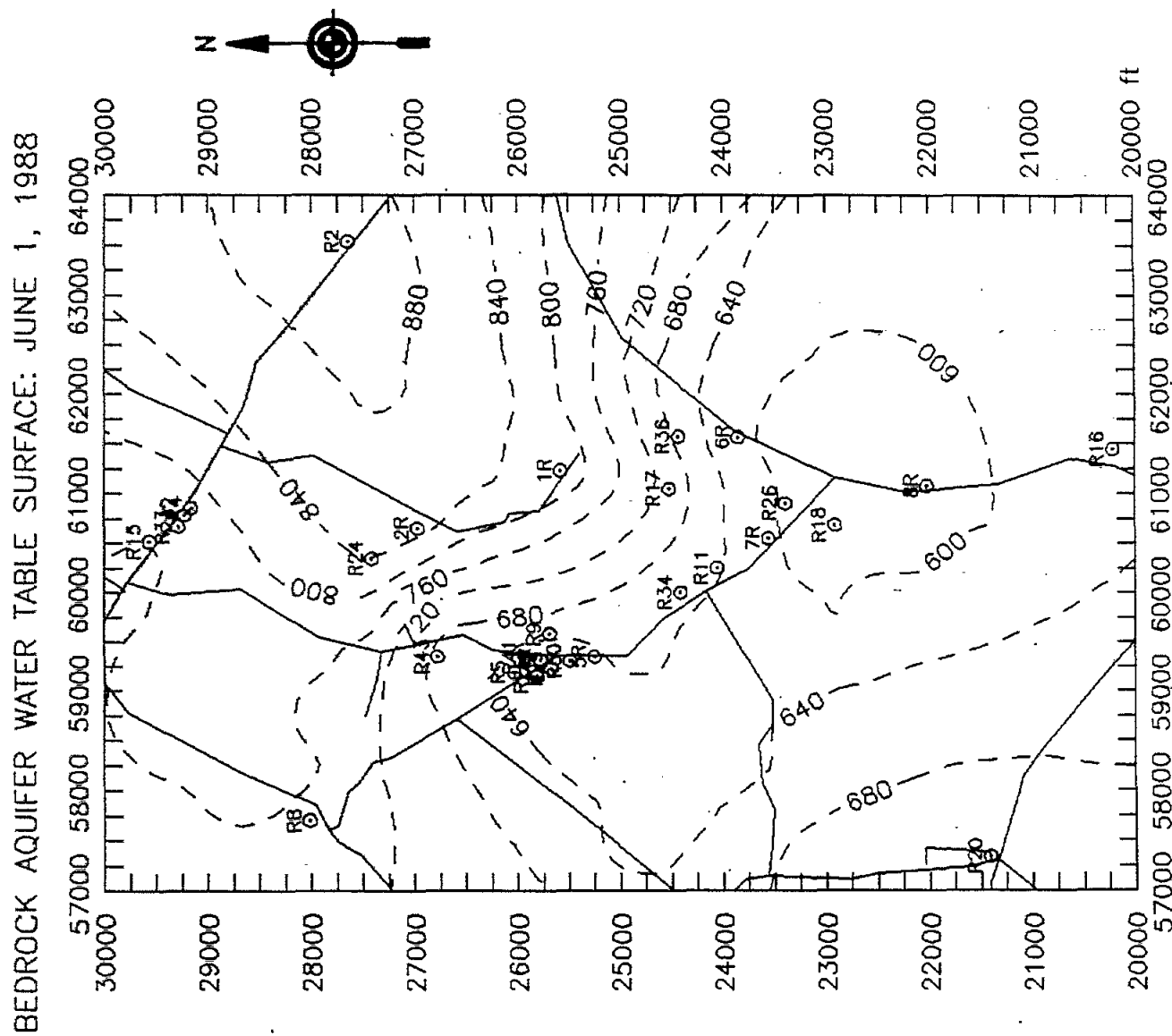
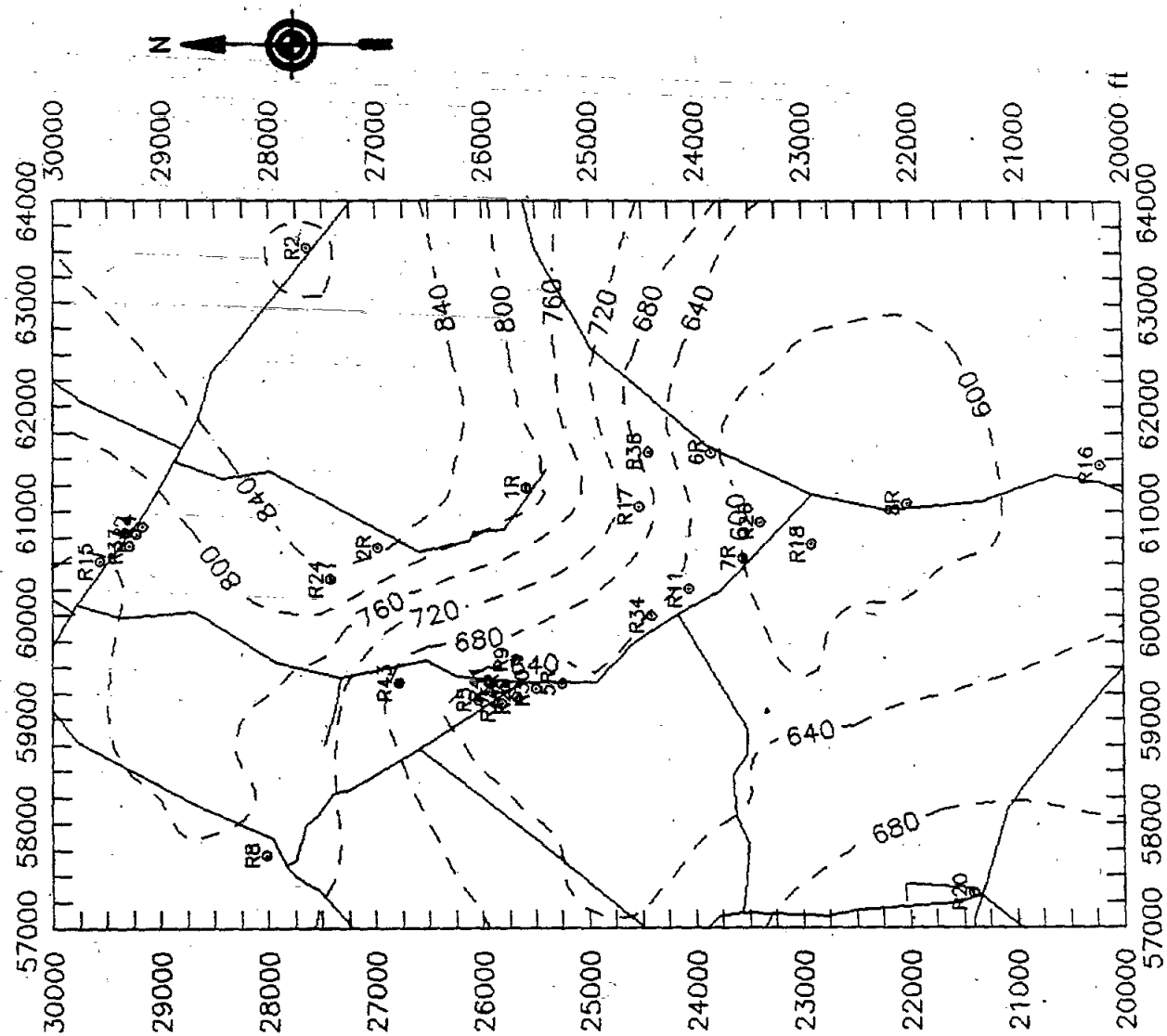


FIGURE 8

BEDROCK AQUIFER WATER TABLE SURFACE: JULY 7, 1988



strongly to the northeast, northwest, and southwest due to a lack of data points in those areas. Regardless, in the central project area, a gradient similar to that exhibited by surface topography and the overburden aquifer is apparent, with flow vectors oriented strongly to the south and west from the crest of Blackhead Hill. The head gradient within the valley trends weakly to the south, again mirroring the regional topographic gradient.

The somewhat anomalous head depression (600 ft. contour) mapped in the lower valley is the result of a limited number of data points to the south, and the influence of well R16 (Eckert) on data from wells 8R, R18, and R26. The latter three wells are constructed in the valley dolomite, and establish a head gradient for that aquifer. Well R16 is located adjacent to and upgradient of the valley in the crystalline bedrock aquifer, and exhibits a higher head evaluation. Consequently, the data from R16 constrain the 600 ft. contour into a circular depression. In actuality, the 600 ft. contour should extend south through the valley bordered on the side slope by a higher elevation contour associated with R16.

Variability between water levels measured during June and July range from 1 to 10.5 ft., with an average variability of 5.3 ft. As with the overburden system, these seasonal water level fluctuations have no apparent effect on regional gradients or inferred flow lines.

Well clusters installed at most of the well drilling sites allow for a determination of the vertical head gradient between and within the overburden and bedrock aquifers. In nearly all cases, a downward flow vector is apparent between the overburden and shallow bedrock, and within the overburden itself (Sites 1, 2, 3, 5, and 6). An extremely strong downward gradient is indicated at Site 4; however, the thickness of physical separation between the overburden and bedrock wells at this location precludes a direct hydraulic relationship between the two aquifers at this site (refer to long term pump test data, Report Section 4.1.2.2). Data from Site 7 show a very weak downward gradient, indicative of essentially lateral flow conditions.

A weak upward vector is noted between the overburden/shallow rock wells and the deep rock well at Site 2. A stronger upward gradient is noted between the deep overburden and bedrock well at Site 5. At Site 2, these data represent confined head conditions in the massive (unfractured) gneiss aquifer. The stronger upward gradient at Site 5 may be an indication of regional discharge to the valley area, or simply an expression of confined head potential at the lower topographic elevation (relative to Site 2).

#### 4.1.2 Aquifer Parameters

A series of field tests were performed in the wells installed by ERT/REAC to estimate the horizontal permeability (saturated hydraulic conductivity) of the overburden materials and fractured bedrock. These tests consisted of slug tests in all of the overburden and bedrock wells and a long term pump test at well Site 4. Prior to

discussing the results of these tests, a brief summary of terms associated with their evaluation is provided below.

In order to estimate the velocity of groundwater flow in an aquifer, or attempt to simulate contaminant migration, several basic aquifer parameters must be known. The most important of these are aquifer transmissivity, hydraulic conductivity, and storativity. Both hydraulic conductivity (or permeability) and transmissivity represent the ability of an aquifer material to transmit water. Hydraulic conductivity (K) is the rate at which water will flow through a unit cross-sectional area of the aquifer under a unit head. Aquifer transmissivity (T) represents the rate at which water will flow through a vertical strip of the aquifer under a unit head. The two terms are related by the relation  $T = Kb$ , where "b" is the saturated thickness of the aquifer.

The analysis of pump test data allows for the calculation of aquifer transmissivity; hydraulic conductivity must be calculated from a knowledge of the saturated thickness of the aquifer. The analysis of slug test data allows for a direct estimation of hydraulic conductivity, although the slug test is valid only for conditions prevailing in a small radius around the borehole.

The storage coefficient (or storativity) of an aquifer can be determined accurately only through the performance of a multiple well pump test (i.e., a pumping well and one or more observation wells to monitor drawdown). The storage coefficient is the volume of water released from or taken into storage per unit area of aquifer for a unit change in head. The value of the storage coefficient (a dimensionless term) indicates whether the subject aquifer system is unconfined (water table aquifer) or under pressure (confined).

#### 4.1.2.1 Slug Tests

A slug test refers to a method of which a known volume of water is either added or removed from a well, and the time-drawdown or recovery of the water level is monitored. Slug tests are generally performed in wells that are anticipated to have low yields, or where casing diameter limitations preclude performance of standard pump tests. When water is removed from a well, the test is more correctly called a bail test. Both slug and bail tests were used during the testing program in Hereford to derive an optimal set of time series data for each well.

Drawdown and/or recovery data were obtained through the use of Campbell Scientific 21X Micrologger (datalogger) and a Druck PDCR 10/D pressure transducer. The procedure used to estimate hydraulic conductivity is that developed by Hvorslev (1951). A description of this method, and the data used to derive the permeability estimates are contained in Appendix D. That appendix also provides time series data plots for each well test. Table 3 summarizes the results of the slug tests.

TABLE 3  
RESULTS OF SLUG TEST ANALYSES

OVERBURDEN WELLS			BEDROCK WELLS		
WELL	HYDRAULIC CONDUCTIVITY (gpd/sq ft) (cm/sec)		WELL	HYDRAULIC CONDUCTIVITY (gpd/sq ft) (cm/sec)	
10B	0.4	$1.9 \times 10^{-5}$	1R	642	$3.0 \times 10^{-2}$
1.10B	8.1	$3.8 \times 10^{-4}$	2R	1725	$8.2 \times 10^{-2}$
1.20B	2.5	$1.2 \times 10^{-4}$	2DR	0.02	$9.5 \times 10^{-7}$
2.10B	7.4	$3.5 \times 10^{-4}$	4R	439	$2.1 \times 10^{-2}$
30B	3.0	$1.4 \times 10^{-4}$	5R	1.4	$6.6 \times 10^{-5}$
3DOB	3.7	$1.8 \times 10^{-4}$	6R	1265	$6.0 \times 10^{-2}$
40B	3.6	$1.7 \times 10^{-4}$	7R	601	$2.8 \times 10^{-2}$
50B	7.7	$3.6 \times 10^{-4}$	7DR	1699	$8.0 \times 10^{-2}$
5DOB	1.0	$4.6 \times 10^{-5}$	8R	29	$1.4 \times 10^{-3}$
60B	1.0	$4.7 \times 10^{-5}$			
70B	2.9	$1.4 \times 10^{-4}$			

NOTE: Monitor well 2-OB was not tested due to a negligible water column during the field analytical period.

Hydraulic conductivity data for the overburden materials across the project area are very uniform, and vary only within one order of magnitude. The average permeability for all overburden wells is  $1.8 \times 10^{-4}$  cm/sec (3.75 gpd/ft<sup>2</sup>). These data are consistent with literature values for fine sands and silts (Dunne and Leopard, 1978, Todd, 1980), of which the saprolite and alluvial deposits within the Town of Hereford are comprised.

Normally, slug tests data from bedrock wells are of value only in a qualitative sense, since the derived hydraulic conductivity is an average across the entire open borehole. The open communication zone in bedrock wells installed as part of this project, however, were generally limited to the thickness of productive fracture systems intercepted during drilling (refer to Table 1). Consequently, in all but two cases, the data indicated on Table 3 are reasonably accurate estimates of permeability within discrete fracture systems.

The exceptions noted above are associated with wells 2R and 5R. These wells exhibit long open boreholes (249 and 104 ft., respectively) because exploratory drilling did not encounter any zones of high yield above the limiting well construction depth of 300 ft. This is apparent from the calculated permeability data, as even if the averaging effect of the long boreholes is taken into account, the derived permeabilities are 2 to 4 orders of magnitude lower than those exhibited in the other wells.

Excluding these two wells, the average hydraulic conductivity of fracture flow systems intercepted by ERT/REAC installed wells is  $4.3 \times 10^{-2}$  cm/sec (914 gpd/sq. ft). Further excluding well 8R (in which a discrete productive zone was difficult to identify, yielding a corresponding longer open borehole length of 45 ft.), provides a better average of  $5.0 \times 10^{-2}$  cm/sec (1062 gpd/sq. ft.). These data indicate a very productive fracture flow system throughout the project area, capable of supporting high yields and rapid groundwater movement.

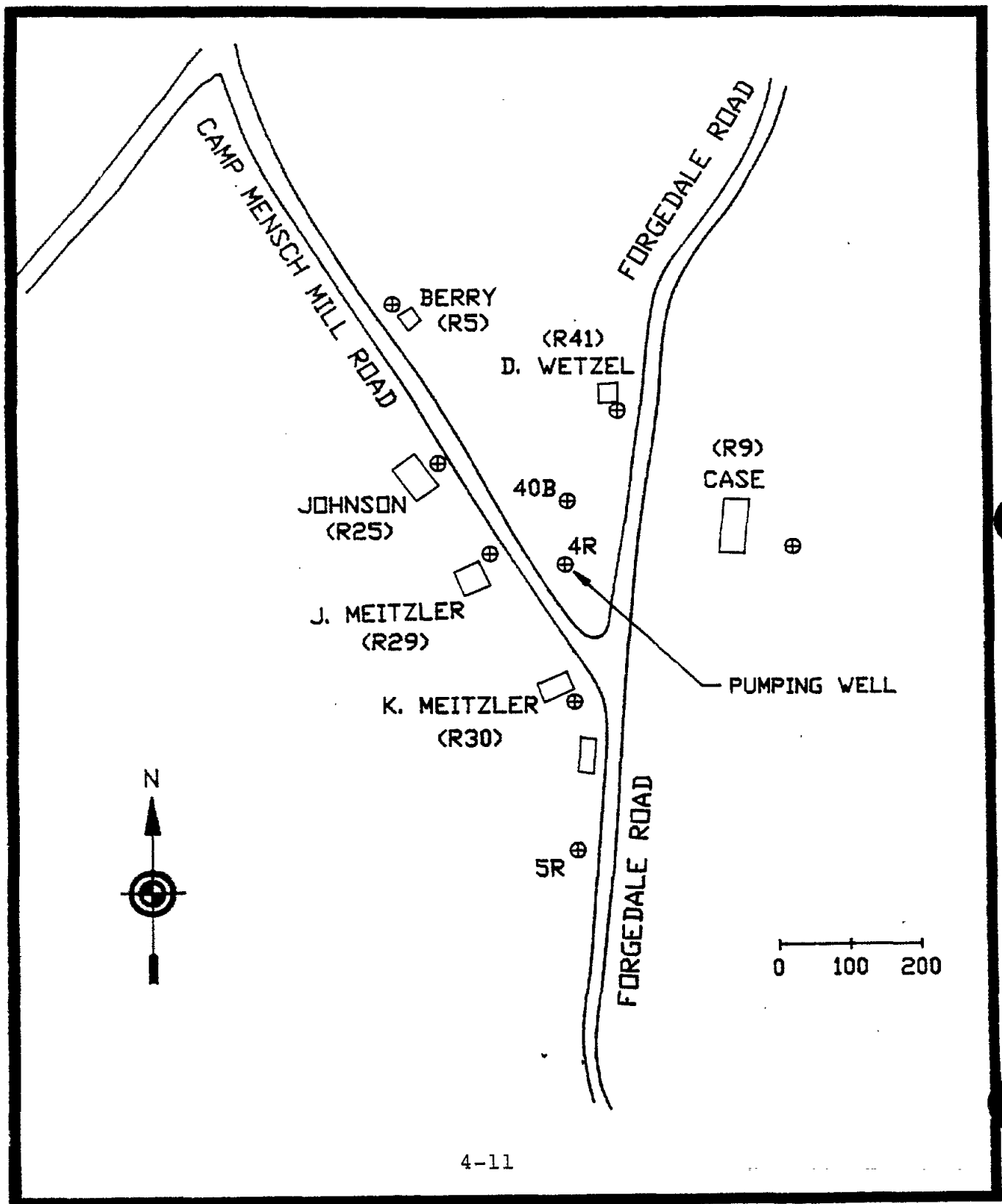
#### 4.1.2.2 Pump Test

A long term, multiple well pump test was performed as part of this investigation in order to provide a more rigorous evaluation of fractured rock aquifer hydraulics than that available through slug test analysis. The test was located in the area where the highest contaminant concentrations were noted from residential well sampling, down gradient of Blackhead Hill along a mapped fracture zone. Figure 9 indicated the location of the pumping well (MW-4R) and observation wells monitored during the test.

The scope of field activities for the pump test consisted of three components: 1) antecedent monitoring, 2) drawdown and recovery monitoring, and 3) chemical monitoring. Hydraulic monitoring activities are described in this report section; the design of the treatment system for pump test discharge, and the results of chemical analysis of wellhead and treatment system effluent sampling are contained in report Section 4.2.2.3.

FIGURE 9

LOCATION OF PUMPING AND OBSERVATION WELLS



AR100032



#### 4.1.2.2.1 Antecedent Monitoring

Water levels were monitored continuously in wells MW-4R and MW-40B for a 72 hour period prior to initiation of the pump test. Measurements were made at five minutes intervals over the test period using two Druck PDCR 10/D Pressure Transducers connected to a Campbell Scientific Micrologger (datalogger). The purpose of this monitoring was to identify any cultural or environmental influences on static water levels within the test wells that would need to be accounted for in the interpretation of pump test monitoring data. Time series plots of the monitoring data for both the shallow overburden well (40B) and deep bedrock well (4R) are contained on Figure 10.

Figure 11 presents time series charts of measured barometric pressure and precipitation measured at Allentown, Pa. for the same antecedent monitoring period. These two phenomena represent the environmental factors most likely to influence water levels in the monitoring wells. (Barometric pressure is a relevant factor only in the case of confined aquifer systems.)

The data plot for the overburden well show a range of variability (0.3 ft.) normal for a shallow water table aquifer experiencing periodic recharge from several brief rainfall events. The data from the deep rock well are more interesting in two regards: 1) the presence of a regional groundwater discharge (recession) curve, and 2) a significant response to the rainfall event noted between 3000 and 3400 min. Comparison of the barometric pressure data with well 4R on Figure 10 does not indicate any apparent correlation. Consequently, the barometric efficiency of the well is very low, indicating partially rather than fully confined conditions in the aquifer, presumably due to its proximity to the source areas of recharge (high angle fractures) along Blackhead Hill.

The recession curve represents the rate of aquifer outflow to the regional discharge area, presumed to be Perkiomen Creek in the project area. This curve appears to reestablish itself following the recharge peak noted between 3000 and 4000 min. Consequently, measured drawdown and recovery data obtained during the pump test were corrected to account for the discharge rate.

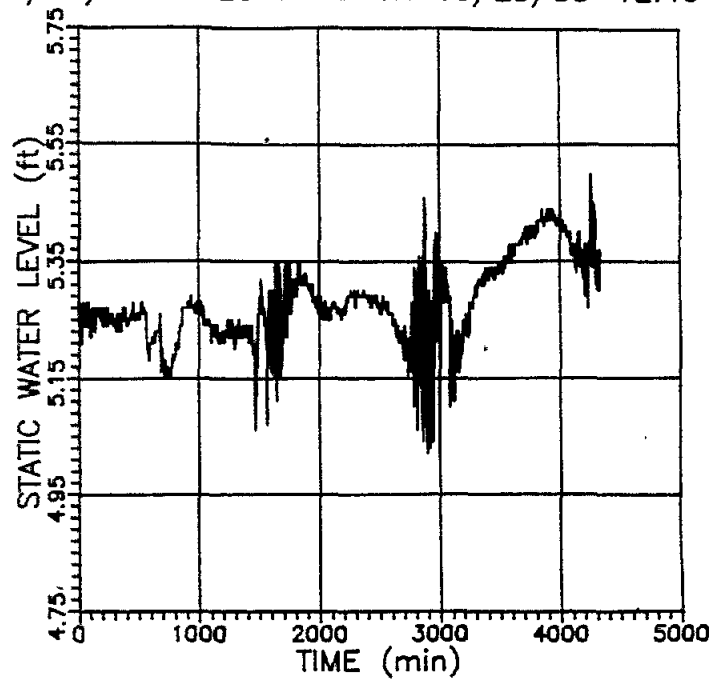
The sharp rise in the static water level within well MW-4R coincident with a large precipitation event at 3000 min, indicates that the fractured bedrock aquifer is recharged rapidly by rainfall through the high angle fractures mapped along Blackhead Hill. This may explain the high variability in contaminant concentrations observed in historical residential monitoring data (report Section 4.2.2.1).

#### 4.1.2.2.2 Drawdown and Recovery Monitoring

Pump testing in MW-4R was initiated at 5 pm on May 23, 1988, and continued for a period of 48 hrs. Several weeks prior to testing, EPA/ERT distributed a letter to all residences in the affected area

FIGURE 10

ANTECEDENT WATER LEVEL MONITORING: MW-4-OB  
05/20/88-12:20 THROUGH 05/23/88-12:40



ANTECEDENT WATER LEVEL MONITORING: MW-4-R  
05/20/88-12:20 THROUGH 05/23/88-12:40

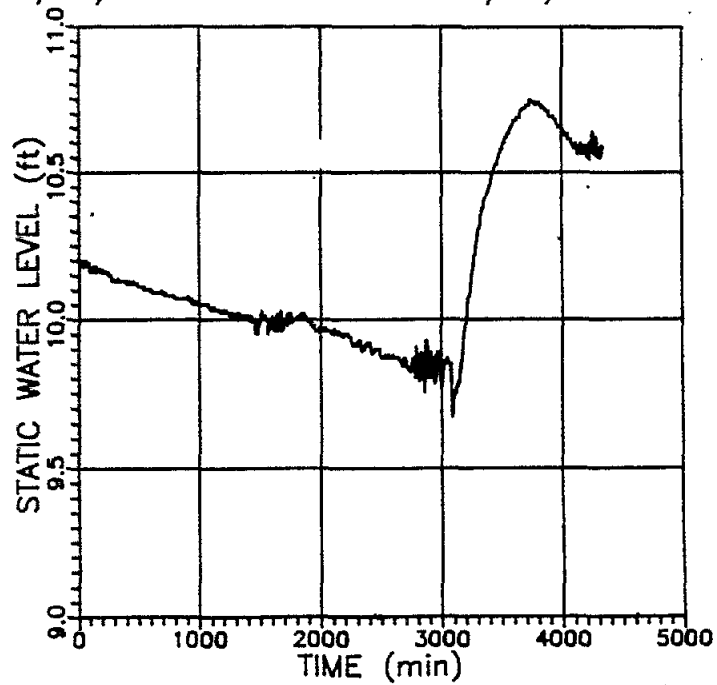
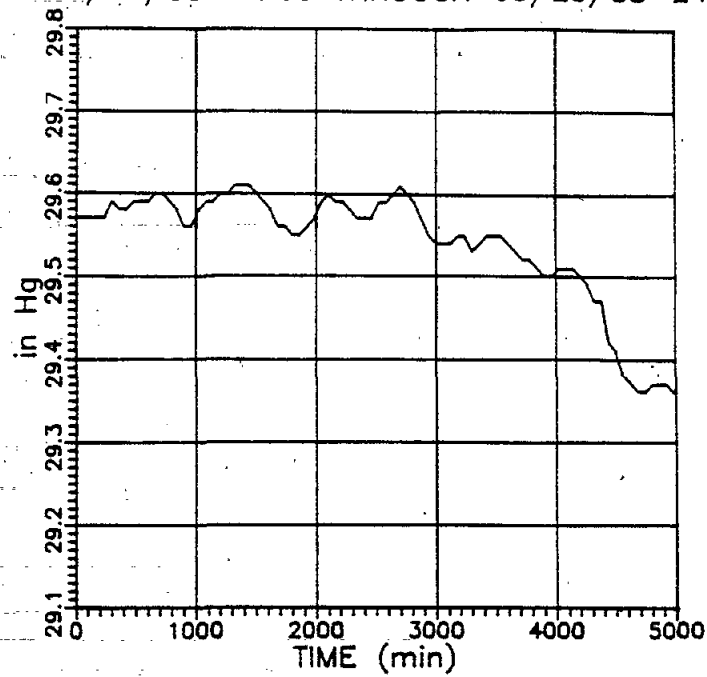
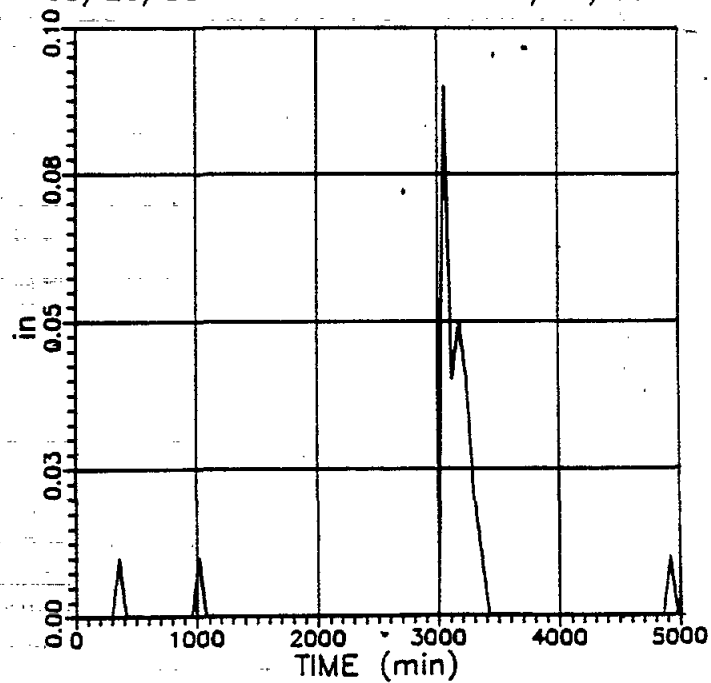


FIGURE 11

BAROMETRIC PRESSURE (ALLENTOWN, PA)  
05/20/88-12:00 THROUGH 05/23/88-24:00



MEASURED RAINFALL (ALLENTOWN, PA)  
05/20/88-12:00 THROUGH 05/23/88-24:00



informing them of the testing schedule, and requesting that water use be controlled during that period. Drawdown measurements were recorded in Wells 4R, 40B, and the D. Wetzel residence (R41) using the pressure transducer/datalogger system described earlier. Water levels were measured manually using electric tapes in the Berry (R5), Johnson (R25), J. Meitzler (R29), K. Meitzler (R30), and Case (R9) residences, and in monitor well MW-5-R. Subsequent to pump shutoff on May 25, water level recovery monitoring was performed for a maximum period of 17 hours. Appendix E contains tabular records of the collected drawdown/recovery data. As noted earlier, these data were corrected by the observed regional groundwater discharge rate of 0.000127 ft/min.

With the exception of the initial several hours, pump discharge was maintained at a rate of 50 gpm throughout the test period. A high silt content in the well discharge during the early phase of the test required continuous shunting of flow between treatment system prefilters, resulting in episodes of pressure head build-up and release. The variations in system back pressure precluded maintenance of a steady flow rate until about 200 min into the test, (i.e., until the silt load was extracted from the test zone of the aquifer).

Aquifer parameters were derived from the pump test data through application of the "Jacob Straight Line" method (modified non-equilibrium equation). This semi-log method is based on a simplification of the Theis equation, and utilizes the slope of the time drawdown curve to estimate transmissivity, and the point of interception of the time drawdown curve with the zero drawdown axis to estimate the aquifer storage coefficient (Driscoll, 1986).

Use of the modified non-equilibrium equation is strictly appropriate only in the case of confined aquifers. However, Senay (1987) and others have indicted its applicability under a wide range of aquifer conditions. The most important criterion in its use concerns numerical bounds associated with the well function ( $u$ )\*. The straight line method should not be applied if the value of  $u$  is greater than 0.01-0.05 (Lohman, 1979, Senay, 1987). Calculation of  $u$  for all observation wells monitored during the Hereford pump test indicates that use of the modified non-equilibrium equation is acceptable in all cases.

Solution plots for all wells yielding data amenable to analysis are contained in Appendix E. Aquifer parameters derived from these plots are summarized in Table 4. Visual examination of these plots indicates that, with the exception of early pump discharge variations noted earlier, the data tend to conform to the idealized (confined aquifer) response curve. Several plots indicate sporadic water usage by homeowners during the drawdown or recovery phase (e.g., Berry, K.

\*  $u = r^2 S / 4 T t'$ , where  $r$  = distance to observation well (ft.),  $S$  = estimated aquifer storage coefficient,  $T$  = estimated aquifer transmissivity (ft<sup>2</sup>/day), and  $t'$  = length of pump test (days).

TABLE 4  
SUMMARY OF AQUIFER PARAMETERS DERIVED FROM LONG TERM PUMP TEST

WELL	DRAWDOWN DATA		RECOVERY DATA [b]
	TRANSMISSIVITY (gpd/ft)	STORAGE COEFFICIENT	TRANSMISSIVITY (gpd/ft)
MW-4-R	15529 [a]	[b]	14667 [a]
BERRY (R5)	20308	$1.1 \times 10^{-3}$	16500
JOHNSON (R25)	22000	$3.2 \times 10^{-4}$	13200
MEITZLER, J. (R29)	23158	$5.3 \times 10^{-4}$	14505
MEITZLER, K. (R30)	34737	$7.7 \times 10^{-4}$	21640
AVERAGE	23146	$6.8 \times 10^{-4}$	16102

[a] The pumping well is the only well monitored during the pump test for which the thickness of the saturated zone is known (11 ft). Consequently, a hydraulic conductivity can be calculated for the aquifer within the vicinity of this well follows ( $K=T/b$ ):

Drawdown data:  $(15529 \text{ gpd/ft}) / (11 \text{ ft}) = 1412 \text{ gpd/sq ft}$

Recovery data:  $(14667 \text{ gpd/ft}) / (11 \text{ ft}) = 1333 \text{ gpd/sq ft}$

[b] Calculation of the storage coefficient can not be performed from drawdown data in the pumping well. In addition, use of the preferred method of recovery data analysis (i.e.  $s'$  vs.  $t/t'$ ) does not allow for a direct computation of the storage coefficient.

Meltzler); these minor deviations did not affect graphical solution. Evidence of boundary condition effects is noted in both the drawdown and recovery plots from the Berry residential well (i.e., significant change in slope between the early and late test periods). These effects may be related to induced recharge from Perkiomen Creek or more highly fractured media in a zone of weakness represented by the stream corridor area, and result in the calculation of a storage coefficient one order of magnitude greater than that derived from the other test wells.

Due to the previously noted variability in pump rate during the initial stage of the test, the recovery data are considered more valid in the estimation of aquifer transmissivity. As indicated on Table 4, the drawdown data are more variable than those associated with recovery, and differ more significantly from the data derived from the pumping well. Other factors that contribute to variation in the transmissivity estimates include aquifer anisotropy, and differing (unknown) lengths of open borehole in the residential wells.

As indicated on Table 4, a value for the hydraulic conductivity of the tested aquifer system can be derived only for monitor well 4R, because that is the only well in which a saturated thickness is known. The calculated value of K is about 1350 gpd/ft<sup>2</sup>, based on an open borehole length of 11 ft. This value is roughly three times that estimated from the instantaneous discharge (slug) test (Table 3). The slug test estimate agrees fairly well with that derived from the pump test, given that the former are generally conceded to be accurate only within one order of magnitude.

Estimated values for the storage coefficient range from  $1.1 \times 10^{-3}$  to  $7.7 \times 10^{-4}$ , indicative of partially confined or confined conditions in the deep aquifer influenced by the pump test. Lack of any measurable drawdown in well 40B supports this finding. Three additional wells also did not experience any drawdown during the test: D. Wetzel (R41), Case (R9), and monitor well 5R. (Drawdown and partial recovery data for these three wells and well 40B are contained in Appendix E). The two residential wells are located hydraulically upgradient of the test well. It is hypothesized that, given the strong head gradient associated with Black Head Hill and the measured high permeability of the fractured aquifer, the pump rate of the test was not sufficient to influence these wells. In the case of well 5R, slug test data (Table 3) indicate a very low permeability, suggesting that this well does not intercept the fracture flow network influenced by the pumping well.

#### 4.1.3 Groundwater Flow Velocity

There are three groundwater flow components associated with the spread of contaminants from the Blackhead Hill area: vertical and horizontal in the overburden, and within fracture zones in the bedrock. Previously derived hydraulic conductivity and head data allow for the rough estimation of velocities in the overburden. Data from the pump test in well 4R allow for an estimation of fracture zone flow in the bedrock.

Velocity estimates are obtained through application of Darcy's Law, as follows:

$$v = (K[dh/dl]) / (7.48)n$$

where:  $v$  = average velocity (ft/day)  
 $K$  = hydraulic conductivity (gpd/ft<sup>2</sup>)  
 $dh/dl$  = hydraulic gradient (ft/ft)  
 $n$  = porosity  
7.48 = conversion factor (gpd/ft<sup>2</sup> -- ft/day)

While the calculation of flow rates is very approximate using this one dimensional, steady-state approach, the results are of some value in estimating the existing boundaries of contamination and providing a means to assess longterm contaminant migration. If it is assumed that the rock matrix is extensively broken-up and weathered within the fracture flow and structural contact flow systems evident in the project area, then application of the Darcy flow equation is less problematic. The greatest potential for error in lateral velocity estimation occurs where a strong vertical gradient is apparent, or where the fracture system acts as a pipe flow network. Estimation of porosity from literature values represents an additional source of error (more significant within the bedrock aquifer than within the overburden).

The relationship between horizontal/vertical hydraulic conductivity for overburden materials is reported in the literature to range from less than 3:1 to 10:1 (Freeze and Cherry, 1979). Todd (1980) indicates a ratio of 6:1 for alluvial materials that lies midway between the range presented above. Using this latter estimate, an average porosity of 0.30 for saprolite (Dunne and Leopold, 1978), the average horizontal hydraulic conductivity for overburden materials of 3.75 gpd/ft<sup>2</sup> derived in report section 4.1.2.1, and a vertical gradient of 0.7 ft/ft exhibited at well Site 1 on June 1, 1988 (Table 2) yields an average vertical velocity for the Blackhead Hill recharge area of 0.2 ft/day.

Lateral velocities in the overburden are calculated to be 0.04 ft/day across the gently sloping upper surface of Blackhead Hill (MW-2.1-OB, MW-1-OB), 0.18 ft/day along the steep slope to the south of Blackhead Hill (MW-1-OB, MW-6-OB), and 0.28 ft/day along the very steep slope to the west of Blackhead Hill (MW-1.2-OB, MW-3-OB). These estimates are based on the average horizontal hydraulic conductivity and porosity noted above for overburden materials, and head gradients of 0.025, 0.11, and 0.17 ft/ft for well pairs 2.1OB-1OB, 1OB-6OB, and 1.2OB-3OB, respectively, using June 1, 1988 data from Table 2.

Calculation of flow velocity within weathered fracture and structural contract zones is based on the hydraulic conductivity estimated from the pump test at Well 4-R (1350 gpd/ft<sup>2</sup>), and a porosity of 0.45 (Todd, 1980). The porosity estimate represents the upper limit of values reported in several sources for weathered granite.

Horizontal flow velocities in the bedrock are estimated to be 38 ft/day between the Blackhead Hill recharge area and the valley to the west (based on a June 1, 1988 head gradient of 0.095 ft/ft between wells 1-R and 5-R), and 2.8 ft/day within the valley itself (based on a head gradient of 0.007 ft/ft between wells 7-R and 8-R). These velocity estimates are extremely high (even accounting for the use of a very high porosity value), and could easily support the extent of contaminant migration evidenced in the project area, as detailed in the following report section.

## 4.2 Chemical Sampling and Analysis

### 4.2.1 Soil Gas Survey

An extensive soil gas survey was performed by ERT/REAC on the Crossley Farm property during the period 10-12 March 1988. The purpose of this survey was primary to: (1) test the efficacy of the soil gas technique under marginal environmental conditions (i.e., thin, rocky soils), and (2) provide reconnaissance level estimates of soil/shallow groundwater chemistry in areas inaccessible to heavy equipment (steeply sloped and heavily wooded areas to the west of the crest of Blackhead Hill). In addition to sampling in and downgradient of suspected source areas of contamination (borrow pit and quarry), transects were run in the vicinity of upgradient well locations 2 and 2.1. Further, 11 headspace samples were obtained from monitor wells that had been installed prior to the date of the survey.

As indicated on Figure 12, a total of 89 points were sampled along 17 separate transects (A-Q) during the March survey. A brief trip report describing this work, as well as a tabular summary of raw data from Photovac (GC) analysis of vapor samples, is contained in Appendix F. A follow-up survey was performed on June 29, 1988, in an area where a local resident had described the prior burial of drummed waste. That survey was limited to 13 sample points (Transects R and S on Figure 12). Excerpts from the analytical report on this work are contained in Appendix G.

The analytical results of both surveys are graphically portrayed on Figure 13. This figure illustrates the range of total volatile organic compound (TVOC) concentrations detected across the survey area, and further specifies those locations at which trichloroethene was identified. Areas exhibiting the highest point concentrations for TVOC lie to the south and west of Blackhead Hill, and in the vicinity of well installation site 2.1. High point concentrations within transects M, P, and Q tend to be associated with unknown heavy molecular weight compounds, possibly the result of limited surface spills of fuels or grease associated with the use of farm equipment. The fact that no oil and grease or priority pollutant volatile compounds were detected at monitor well 2.1-OB (Appendices B and I) supports such a hypothesis in the area of Transects P and Q.



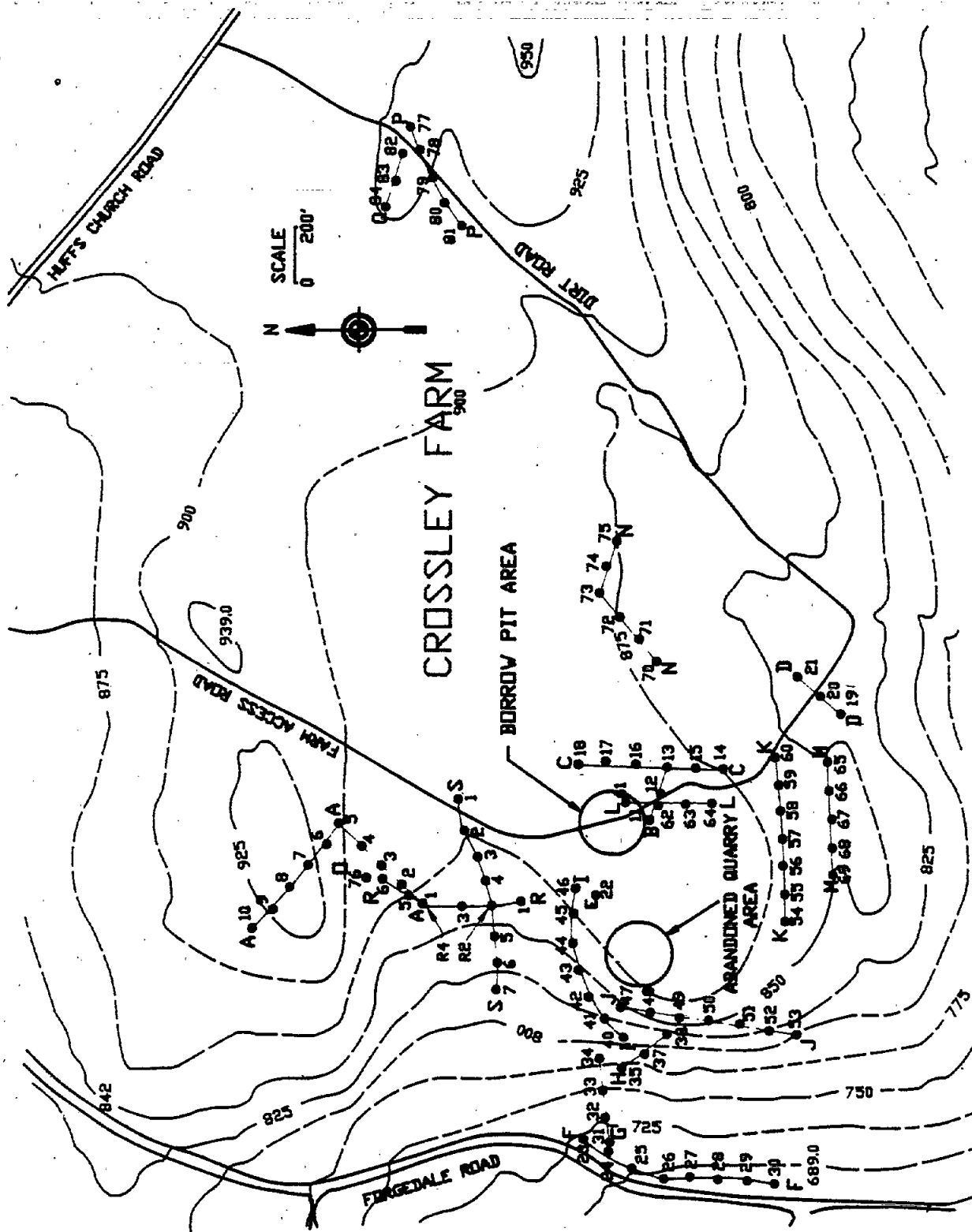


FIGURE 12  
SOIL GAS TRANSECTS AND SAMPLING POINTS

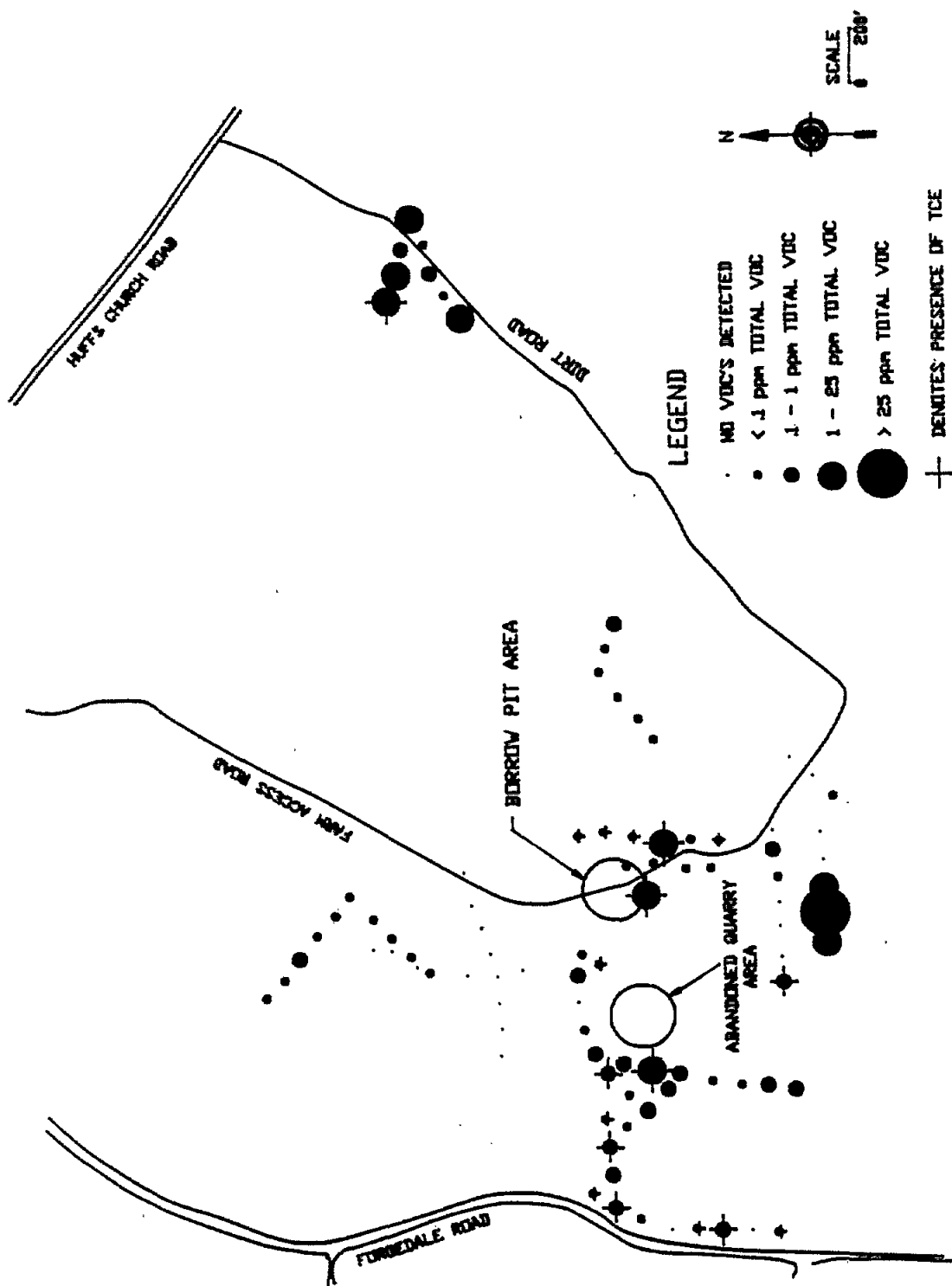


FIGURE 13  
ANALYTICAL RESULTS OF SOIL GAS SAMPLING

Of greater interest in the investigation of the origin of project area contamination than TVOC concentration, is the location of sample points exhibiting the presence of trichloroethene. With the exception of sample point Q84, TCE is indicated only within and adjacent to the borrow pit area and downgradient of the abandoned quarry. Together with the results of monitor well sampling data discussed subsequently, the observed pattern of TCE in soil vapor tends to strongly implicate these two disturbed areas (and underlying fractured rock matrix) as the source areas of regional groundwater contamination.

#### 4.2.2 Groundwater

##### 4.2.2.1 Historical Data-Residential Wells

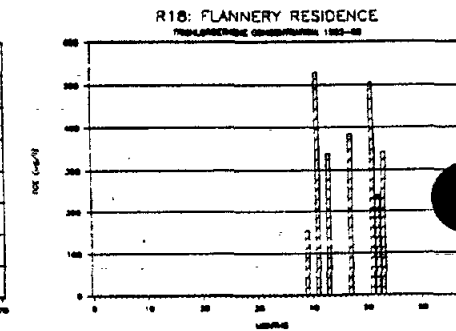
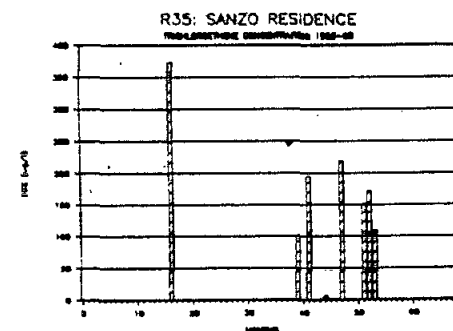
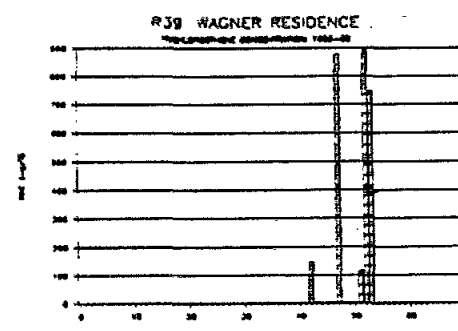
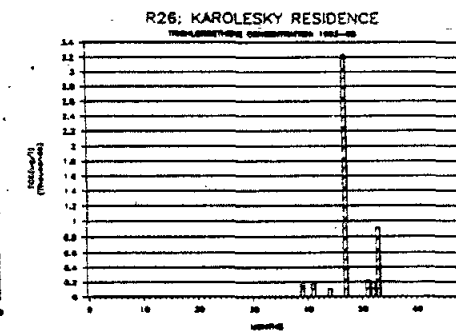
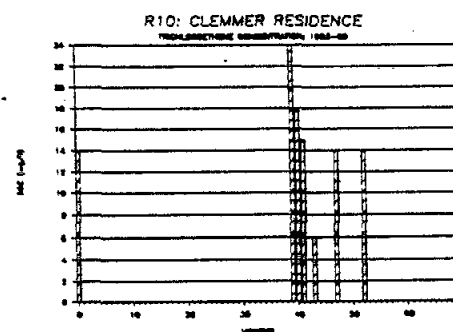
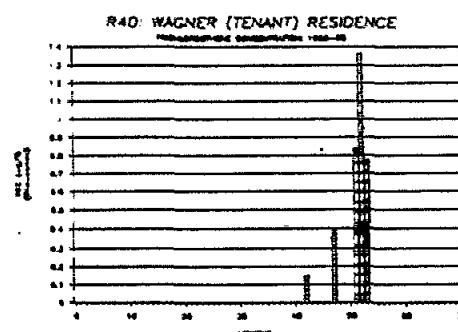
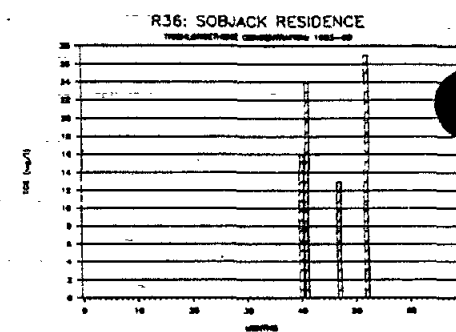
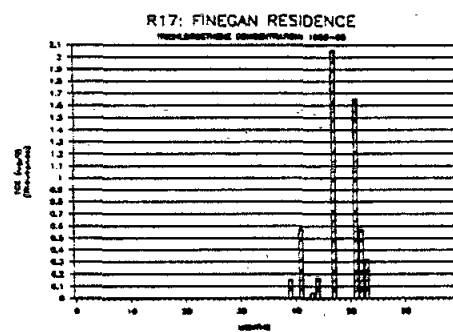
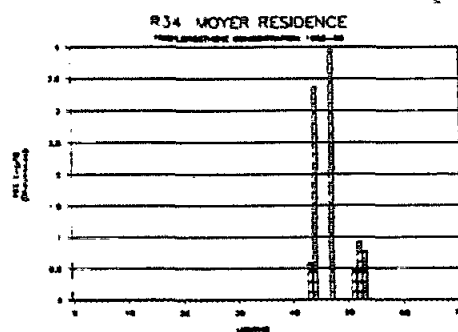
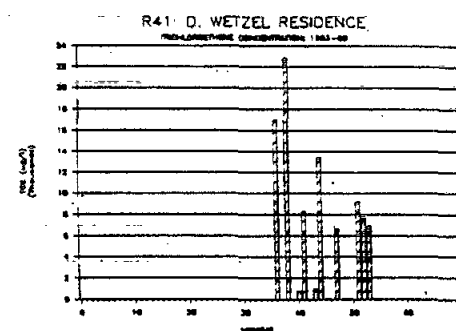
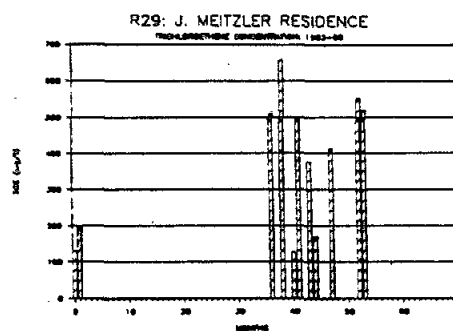
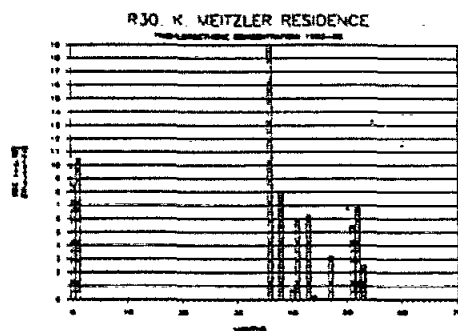
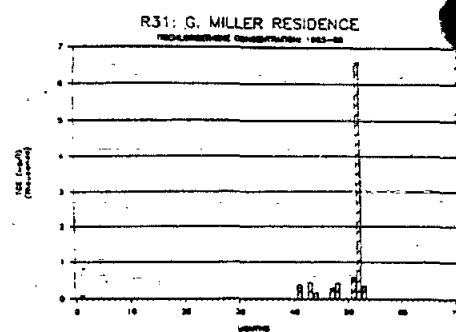
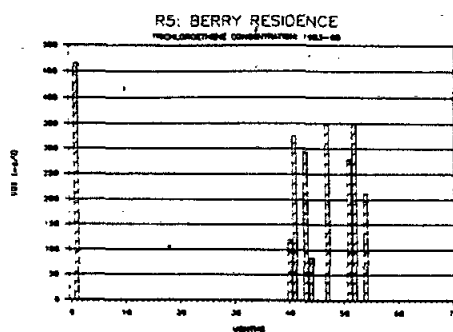
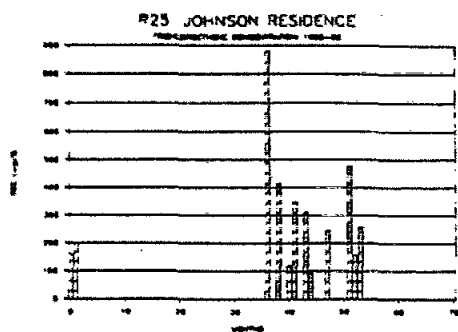
Residential well analytical data has been collected by Region III TAT in the project area on a periodic basis since December of 1986. Limited data is also available from PADER and TAT sampling in the Fall of 1983. Residences sampled are limited primarily to those lying directly west and south of Blackhead Hill, in which point-of-use carbon filtration systems have been installed. Appendix H contains a tabular compilation of these data.

Figure 14 summarizes the historical trichloroethene data record for the majority of residences sampled by TAT. The charts are laid out on the figure in a manner that approximates their relative spatial location from north to south, and west to east. The precise location of the residences is indicated on Plate 1 (oversize map inside back cover of this report). It should be noted that the concentration scales on the plots vary across several orders of magnitude. Plots depicting concentration data from residences located to the north near the Blackhead Hill source area are scaled in the thousands of ppb, while those to the south and west are scaled in hundreds or units.

It is tempting to ascertain trends in contaminant concentrations through time across the project area based on the data contained on Figure 14. For example, three of the residences from which 1983 data are available indicate an overall increase in TCE concentration through time (R10, 25, and 29). However, data from an equal number of residences indicate the opposite trend (R5, 30, and 35). Similarly, data from nine of the residences suggest that a contaminant slug passed through the aquifer system within the 35-50 month period (R10, 17, 25, 26, 30, 31, 34, 40, and 41), while data plotted from the six remaining residences do not exhibit such a singular episode. Consequently, at this level of analysis, no consistent temporal trend in contaminant concentration is evident from the data record.

Of importance in review of the data plots is the wide variability in the sample concentrations at each location. In many cases, nearly a full order of magnitude difference in concentration is noted between

FIGURE 14



samples taken only one month apart. As noted in report Section 4.1.2.2, this is likely the result of the hydraulic character of the fractured aquifer system, i.e., rapid response to recharge events coupled with high system flow velocities. As noted above, such variability acts to strongly limit the potential for time series analysis of the data.

#### 4.2.2.2 ERT/REAC Data - Residential and Monitoring Wells

Early review of the historical data record by ERT/REAC prompted the performance of an interim residential well sampling program during the week of November 7, 1987. One goal of this program was to determine if contaminant migration had extended further south (toward the village of Dale) than the limit of residential sampling performed by TAT, as had been suggested by concentration contour mapping of the contaminant plume.

Table 5 contains trichloroethene concentrations measured for the residential wells sampled in November. Appendix I contains the analytical report from which these data were derived. As indicated, the Debbern residential well (R12), located approximately 1500 ft. south of the intersection of Forgedale Road and Dairy Lane, exhibited an elevated TCE concentration. This finding prompted the siting and installation of monitor well 8-R, and further expansion of the residential well sampling program, as described in the following report section.

During the period May 9-12, ERT/REAC personnel sampled a total of 38 residential wells, and the 20 monitor wells installed during the winter and spring of 1988 (monitor well 2-OB was not sampled, as it was dry for the entire sampling period). This sampling program included a number of residences along Huffs Church Road, and within and north of the village of Dale that had not previously been tested. Sampling along Huffs Church Road was performed to provide additional data to define an upgradient boundary on the extent of regional contamination. Similarly, sampling with and adjacent to Dale was performed to identify the downgradient limit of the waste plume.

Table 6 is a summary of the analytical results for volatile organic compounds (VOCs) obtained from sampling the ERT/REAC installed monitor wells. Table 7 is a summary of the residential well sampling program. The laboratory analytical report from which these data were derived is contained in Appendix J. In addition to trichloroethene, which is by far the most ubiquitous contaminant, several other VOCs are noted in elevated concentrations at the most highly contaminated wells. These include methylene chloride, toluene, trichlorofluoromethane, and xylene.

Figure 15 is a contour plot of the distribution of the TCE plume throughout the project area, based on the bedrock monitor well and residential well data contained in Tables 6 and 7. The contour lines on this figure represent the log (base 10) of the analytical data,

TABLE 5  
 HEREFORD TOWNSHIP RESIDENTIAL WELL SAMPLING PROGRAM:  
 NOVEMBER 9-12, 1987  
 TRICHLOROETHENE CONCENTRATION (ug/l)

WELL ID #	NAME	Trichloroethene
R-1	Audolph	--
R-5	Berry	637
R-10	Clemmer	21.1
R-11	Crum	2.5[a]
R-12	Debbern	409
R-13	Dewart	--
R-16	Eckert	--
R-17	Finegan	343[a]
R-18	Flannery	441[a]
R-19	Fronheiser	--
R-20	Geisinger #2	--
R-21	Grater	--
R-22	Hausman	--
R-23	Hill	--
R-24	Hoffmeister	--
R-25	Johnson	366
R-26	Karolesky	245[a]
R-29	Meitzler, J.	564
R-30	Meitzler, K.	8380
R-31	Miller, G.	489
R-32	Miller, L.	--
R-34	Moyer	2790
R-36	Sobjack	27.2
R-37	Stephens	--
R-38	Swavely	6.0
R-39	Wagner [residence]	1180
R-40	Wagner [tenant]	392[a]
R-41	Wetzel, D.	12200
R-43	Woodland Mobile Home #1	90.5

-- Compound not detected.

[a] Denotes an approximate value between the detection limit and the limit of quantification.

TABLE 6

HEREFORD TOWNSHIP MONITOR WELL SAMPLING PROGRAM: MAY 9-12, 1988  
VOLATILE ORGANIC COMPOUNDS (ug/l)

WELL	Acetone	1,1-Dichloro- ethene	Ethyl benzene	Methylene chloride	1,1,2,2-Tetra- chloroethene	Toluene	1,1,1-Trichloro- ethane	Trichloro- ethene	Trichloro- fluoromethane	Xylene
MW-1-08	--	--	--	26(a,b)	--	--	--	1027	--	--
MW-1-1-R	--	--	--	550(b)	--	--	--	19630	310(a)	--
MW-1.1-08	--	--	--	--	--	97(a,b)	--	5748	--	21(a,b)
MW-1.2-08	--	--	--	--	--	72(a,b)	--	6845	--	--
MW-2-08	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
MW-2-R	--	1(a,b)	--	--	--	--	1(a)	--	--	--
MW-2-DR	--	--	5(a)	--	--	20	--	--	--	11
MW-2.1-08	--	--	1(a)	--	--	--	--	--	--	--
MW-3-08	--	--	2(a)	--	--	5(b)	--	88	--	2(a,b)
MW-3-08	--	--	3(a)	--	--	29	--	114(b)	2(a)	8
MW-4-08	--	--	83(a)	--	--	89(a,b)	--	1960	--	160(a,b)
MW-4-R	31(a)	17(a,b)	--	--	13(a)	--	--	2047(b)	23(a)	--
MW-5-08	--	--	--	--	--	24	--	--	--	--
MW-5-08	3(a,b)	2(a,b)	--	3(a,b)	--	--	2(a)	69(b)	--	--
MW-5-R	--	--	--	48(b)	79(a)	--	29(a,b)	4019(b)	38(a)	--
MW-6-08	--	--	--	--	--	3(a,b)	--	--	--	--
MW-6-R (d)	1(a,b)	2(a,b)	--	--	--	1(a,b)	2(a)	35(b)	--	2(a,b)
MW-7-08	--	--	--	--	--	--	--	--	--	--
MW-7-R	--	--	--	--	--	2(a)	--	24	--	--
MW-7-DR	4(a)	--	--	--	--	3(a,b)	--	30(b)	--	--
MW-8-R	5(a,b)	2(a,b)	--	--	2(a)	1(a,b)	1(a)	259(b)	2(a)	--

-- Compound not detected.

(a) Compound detected, but at a concentration below the analytical detection limit for the sample run.

(b) Concentration adjusted to correct for presence of compound in laboratory blank.

(c) Well dry at time of sampling.

(d) Additional compounds detected: MW-6-R: Benzene-3(a); Styrene-4(a)

TABLE 7  
HEREFORD TOWNSHIP RESIDENTIAL WELL SAMPLING PROGRAM: MAY 9-10, 1988  
VOLATILE ORGANIC COMPOUNDS (ug/l)

WELL ID #	NAME	Methylene Chloride	Toluene	Trichloro- ethene	Trichloro- fluoromethane
R-1	Audolph	--	--	--	--
R-2	Bechtel [deep] (c)	--	12	--	--
R-2A	Bechtel [shallow]	--	9	--	--
R-3	Beckner	--	--	--	--
R-5	Berry	12(a,b)	--	347	--
R-6	Brown	--	--	--	--
R-7	Brungard	21	--	--	--
R-8	Camp Mensch Mill: [caretaker]	--	--	--	--
R-8A	Camp Mensch Mill: [camp]	--	--	--	--
R-10	Clemmer	--	--	24(b)	--
R-11	Crum (c)	--	--	--	--
R-12	Debbern	--	--	318	--
R-14	Donovan	--	--	--	--
R-16	Eckert	--	--	--	--
R-17	Finegan	--	--	1280	--
R-19	Fronheiser	--	--	--	--
R-20	Geisinger #2	2(a,b)	--	--	--
R-21	Grater	--	1(a)	--	--
R-22	Hausman	--	--	--	--
R-23	Hill	--	--	--	--
R-24	Hoffmeister	--	--	--	--
R-25	Johnson	--	--	586	--
R-26	Karolesky	--	--	--	--
R-27	Kearns [barn]	--	--	--	--
R-27A	Kearns [residence]	18	--	--	--
R-28	Kuhns	17	--	24	--
R-29	Meitzler, J.	--	--	839	--
R-30	Meitzler, K.	--	--	7221	--
R-31	Miller, G. (c)	146	160(b)	771	57
R-32	Miller, L.	--	--	--	--
R-34	Moyer	112(b)	--	1830	--
R-35	Sanzo	--	--	316	3(a)
R-36	Sobjack	--	--	26	--
R-37	Stephens	14	--	--	--
R-38	Swavely	13	--	--	--
R-39	Wagner [residence]	--	--	1890	--

R-40 Wagner [tenant] -- -- 1414 --  
R-41 Wetzel, D. (c) -- -- 9425(b) 101(a)

-- Compound not detected.

(a) Compound detected, but at a concentration below the analytical detection limit for the sample run.

(b) Concentration adjusted to correct for presence of compound in laboratory blank.

(c) Additional compounds detected:

R-2: Benzene-2(a)

R-11: Acetone-6(a)

R-31: Ethyl benzene-53; Xylene-123(b)

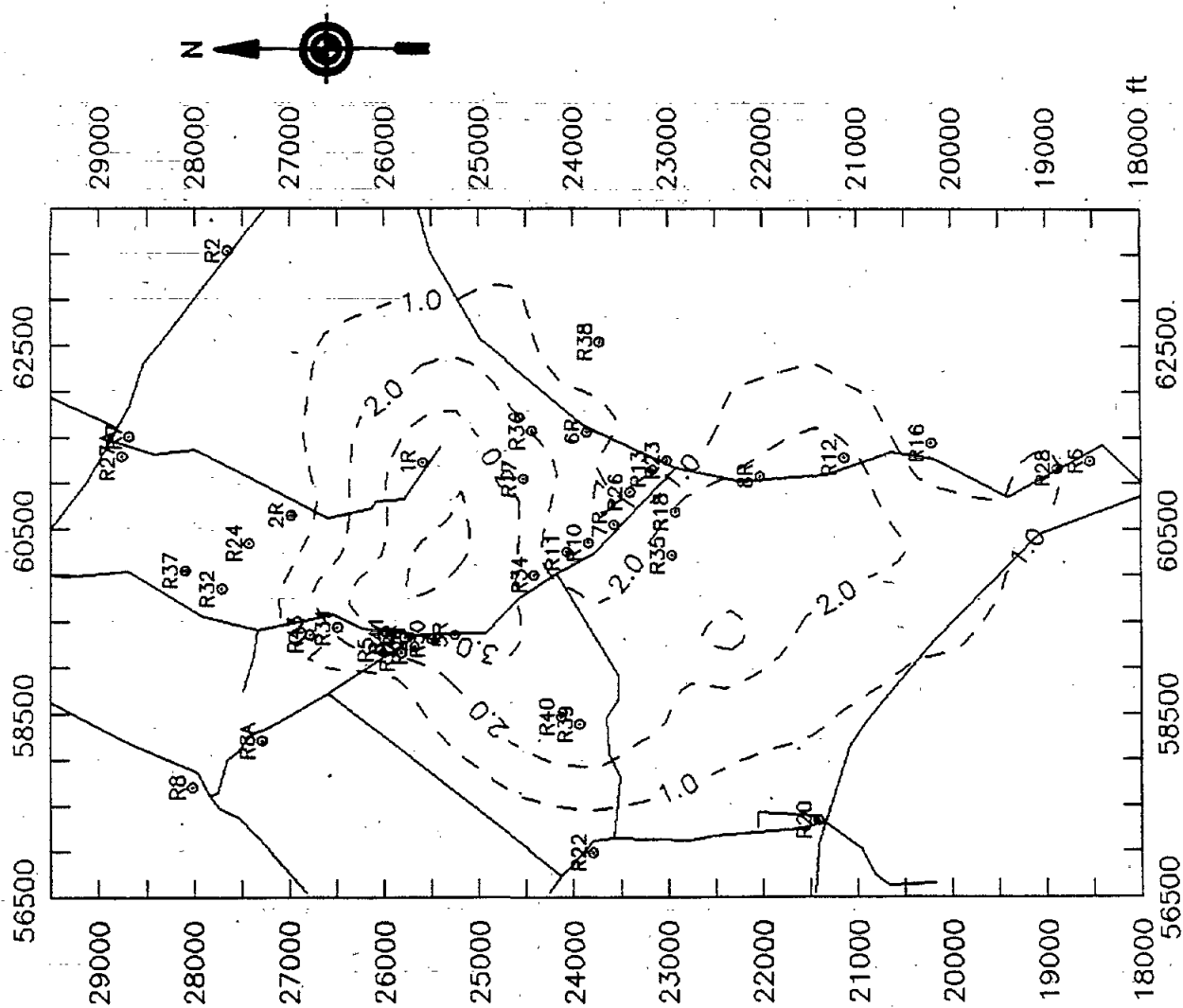
R-41: 1,1-Dichloroethene-67(a,b); 1,1,2,2-Tetrachloroethene-224(a)  
1,1,1-Trichloroethane-52(a)

AR100048



FIGURE 15

BEDROCK AQUIFER-TCE (log ppb): MAY 9-12, 1988



rather than the actual data values. Transformed data are used primarily to provide for more accuracy in the construction of the plume over several orders of magnitude of concentration data. In addition, use of the log scale acts to account for the environmental and analytical variability associated with the point concentration data, and allows for simplifying assumptions (i.e., linear semivariograms) inherent in the kriging procedure used to generate the map.

Figure 15 clearly indicates the crest of Blackhead Hill as the source area of regional bedrock contamination in the project area. The effect of geologic structure (Figure 3) on plume migration from the source area is apparent, with the center of the contaminant mass extending initially to the west and south along mapped faults. The contour plot suggests that the hydraulic connection between the fractured gneiss/quartzite matrix and the valley dolomite occurs preferentially to the west of Blackhead Hill. The southeast trending fault is not continuous to the Dairy Lane area; it is hypothesized that flow within this fracture system is short-circuited to the west along the mapped contact zone. Contamination extends well into the carbonate valley before trending to the south in conformance with the hydraulic gradient. As it approaches Dale, the plume narrows, apparently constrained within the carbonate flow system by the massive crystalline matrix that intrudes from the east and west. The leading edge of the plume appears to lie a short distance north of Dale, exhibiting a total flow path of about 8000 ft.

Figure 16 illustrates the contour plot of shallow water table aquifer (overburden) contamination. The nearly circular shape of the plume is partially a consequence of the location of sample points, although it is reflective of the radial flow pattern associated with contaminant movement from a topographic high. Since monitor well 2-OB was dry during the sampling period, data from well 2R (a shallow rock contact well) was substituted in its place in the generation of the contour plot.

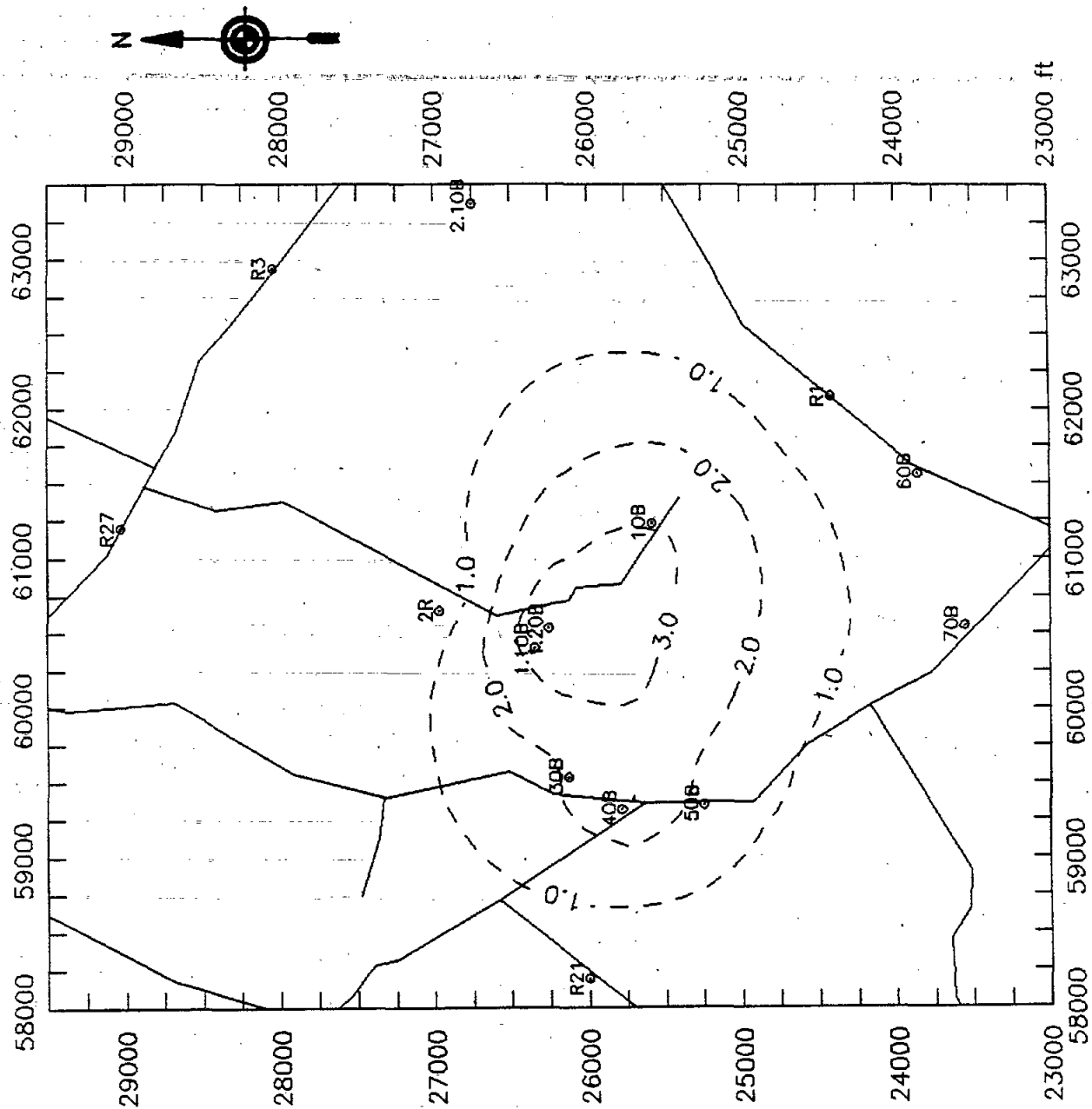
This substitution was deemed appropriate due to the fact that only about 10 ft separate the communication zones of the two wells, and a downward flow gradient is evident at the site (Table 2). Consequently, the analytical data derived from well 2R was judged to be representative of groundwater quality within the overlying saturated soils. Inclusion of the data from MW-2-R acts to limit the northern (upgradient) migration of the concentration contours, and provides a more accurate delineation of contaminant distribution within the overburden sediment. Consistent with the results of the soil gas survey (Figure 13), and the bedrock aquifer contour plot, Figure 16 implicates the abandoned quarry, borrow pit, and adjacent areas as the contaminant source.

#### 4.2.2.3 Time Series Sampling (Pump Test) Data

During the pump test of well 4-R (Report Section 4.1.2.2), time series sampling for volatile organic compounds was performed at the

FIGURE 16

OVERBURDEN AQUIFER-TCE (log ppb): MAY 9-12, 1988



well head, and at the discharge from a mobile carbon adsorption unit through which well discharge was routed. The purpose of the well head sampling is to provide qualitative information regarding the nature of the contaminant plume intercepted by the pumping well (Keely, 1982).

Concentrations of trichloroethene measured from samples obtained at the well head over time are summarized below:

<u>Time (min.)</u>	<u>TCE (ppb)</u>	<u>Time (min.)</u>	<u>TCE (ppb)</u>
10	990	1000	890
60	930	1440	1400
100	920	2000	1400
300	890	2400	1300
500	880	2880	1200
850	900		

These data indicate an immediate high level response for TCE that is maintained over the duration of the test, suggesting location of the test well directly within a large and persistent waste plume. This finding was expected given the historical water quality data record, and the dimensions of the contaminant plume depicted on Figure 15. It should be noted that the jump in contaminant concentration between 1000 and 1440 min. may be the result of sample analysis by two different laboratories (i.e., differing location of sample dilutions on the analytical calibration curve) rather than an actual environmental effect. The analytical reports of data analysis for the 10-1000 min. period and the 1440-2880 min. period are contained in Appendices K and L, respectively.

The pump test treatment system was designed very conservatively in order to assure adequate treatment of discharge water. Design parameters for the pump test were assumed to be 25 ppm TCE (based on highest concentration recorded at the D. Wetzel Well [R41]), 100 gpm flow rate, and test duration of 72 hrs. Based on these parameters, a required carbon volume of 18.5 yd<sup>3</sup> (516 lbs) was suggested by Tigg Corp. (Pittsburgh, PA), based on reference to the carbon adsorption isotherm for trichloroethene. This volume includes a safety factor of 2, to account for the fact that equilibrium conditions cannot be assumed in the flow-through treatment system.

The actual treatment system consisted of two Tigg Corp. C-50 vessels connected in series; each vessel contained 31 ft<sup>3</sup> (868 lbs) of packed virgin carbon. Flow was passed through two prefilter housings fitted with 100 and 50 micron bag filters prior to routing through the carbon vessels. Treated effluent from the carbon filtration system was routed through 1000 ft of 3" hose and discharged into Perkiomen Creek at the Camp Mensch Mill Road bridge. A total of 142,230 gallons of water was passed

through the treatment system over the course of the 40 hour pump test. Subsequent to field demobilization, the spent carbon was removed from the treatment vessels, drummed, and shipped to a regeneration facility.

Analysis of treatment system discharge indicates nondetectable or trace (3-8 ppb) concentrations of TCE through 2000 min., and again at 2880 min. (Appendices K and L). An anomalous concentration of 150 ppb is noted at the 2400 min. sample. This reading is judged to be the result of analytical or sampling error (e.g., use of contaminated sample bottle), and not representative of system discharge for the following reasons: (1) significant overdesign of the treatment system relative to design parameters, (2) performance of the pump test at a flow rate and with a contaminant concentration well below initial design parameters, (3) no evidence of slug loading into the system (i.e., observed steady-state level of contaminant concentration throughout the test), and (4) measured concentration of TCE below the level of quantification (3 ppb) at the conclusion of the test (2880 min.).

## 5.0 DISCUSSION

Synthesis of the hydraulic and chemical sampling data generated through the performance of this regional investigation allows for a determination of the source and extent of groundwater contamination, and suggests a feasible range of remedial actions. Each of these topics are expanded upon below, following an initial recapitulation of significant findings.

### Source of Contamination

The results of soil vapor surveys (Figure 13), water level monitoring (Figures 5-8), and chemical sampling of monitor wells (Figures 15 and 16), implicate several areas near the crest of Blackhead Hill as the source of regional trichloroethene (TCE) contamination. These areas consist of a borrow pit and an abandoned quarry, lying to the south and west, respectively, of the Crossley Farm access road (Figure 12).

A thin remaining soil cover in the borrow pit, and physical inaccessibility to the quarry precluded direct sediment sampling and analysis in these areas. However, soil gas data and information from local residents suggest that the borrow pit was a staging area for drummed waste solvents that were ultimately disposed of elsewhere on the Crossley Farm property. The highest concentrations of TCE recorded in the overburden sediments are associated with monitor wells 1.1 and 1.2-OB, lying directly downgradient of the quarry. These data, and the lack of any other apparent surface disposal areas, point toward the abandoned quarry as the principal contaminant source.

Pumping of liquid waste into the boulder-sized cover material overlying the quarry would have allowed for rapid waste assimilation, with no visual evidence of dumping activities. The vertical distribution of site contamination (elevated levels of TCE within the bedrock aquifer relative to the overburden aquifer) is consistent with the presence of a deep waste source directly in contact with the fracture flow system.

### Extent of Contamination

Within the overburden aquifer, the waste plume extends for an inferred maximum distance of about 1700 ft to the west of Blackhead Hill. A thickness of sediment contamination in excess of 50 ft is apparent based on data from the deep overburden well at Site 3.

Within the crystalline bedrock, contaminant migration is controlled by the geologic structure. Faults and fractures rapidly channel contaminants downgradient to the dolomite valley west of Blackhead Hill. Within the valley, contaminant migration is presumed to occur in enlarged, weathered zones within the carbonate matrix. The lateral extent of the waste plume in the bedrock aquifer is approximately 8000 ft, from the crest of Blackhead Hill to the lower Dale valley. A conservative estimate of the vertical extent of contamination within the fractured aquifer is 225 ft (well 4-R).

### Remedial Options

Due to the fact that there is no apparent surficial waste disposal evident on Blackhead Hill, immediate source removal or immobilization does not appear feasible. Additional sampling within and directly adjacent to the abandoned quarry area should receive a high priority, although the nature of site materials (blasted boulder-sized rubble) and heavy equipment access limitations will necessarily constrain the scope of these activities.

Assuming deep emplacement of wastes within the quarry, remedial action would appear to be limited to control of the fracture flow regime at or immediately downgradient of the crest of Blackhead Hill. Data derived from the pump test at well 4-R and the slug test at well 1-R indicate that such controls will necessitate high rates of pump discharge ( $> 50$  gpm) to be effective. Accurate placement of recovery wells within mapped fault and fracture zones is a critical concern, as the hydraulic data from wells 2-R and 5-R indicate minimal yield within the massive rock matrix.

Due to the nature of site contamination (i.e. chlorinated ethylenes) and the unpredictable (anisotropic) character of the fractured bedrock aquifer, the applicability of in-situ biological techniques of aquifer renovation appear limited. Consequently, the effectiveness of surface physical and/or biological treatment of groundwater within the context of a recovery and injection well system requires further evaluation. Work currently being performed by USEPA and contract personnel through the Robert S. Kerr Environmental Research Laboratory (Ada, Oklahoma) regarding further definition of the bedrock aquifer flow system, should act to assist in this evaluation.

## REFERENCES

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AR100056



APPENDIX A  
WELL CONSTRUCTION DETAILS AND BORING LOGS

AR100057

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 17 DEC 87

Well No.: 1 OB

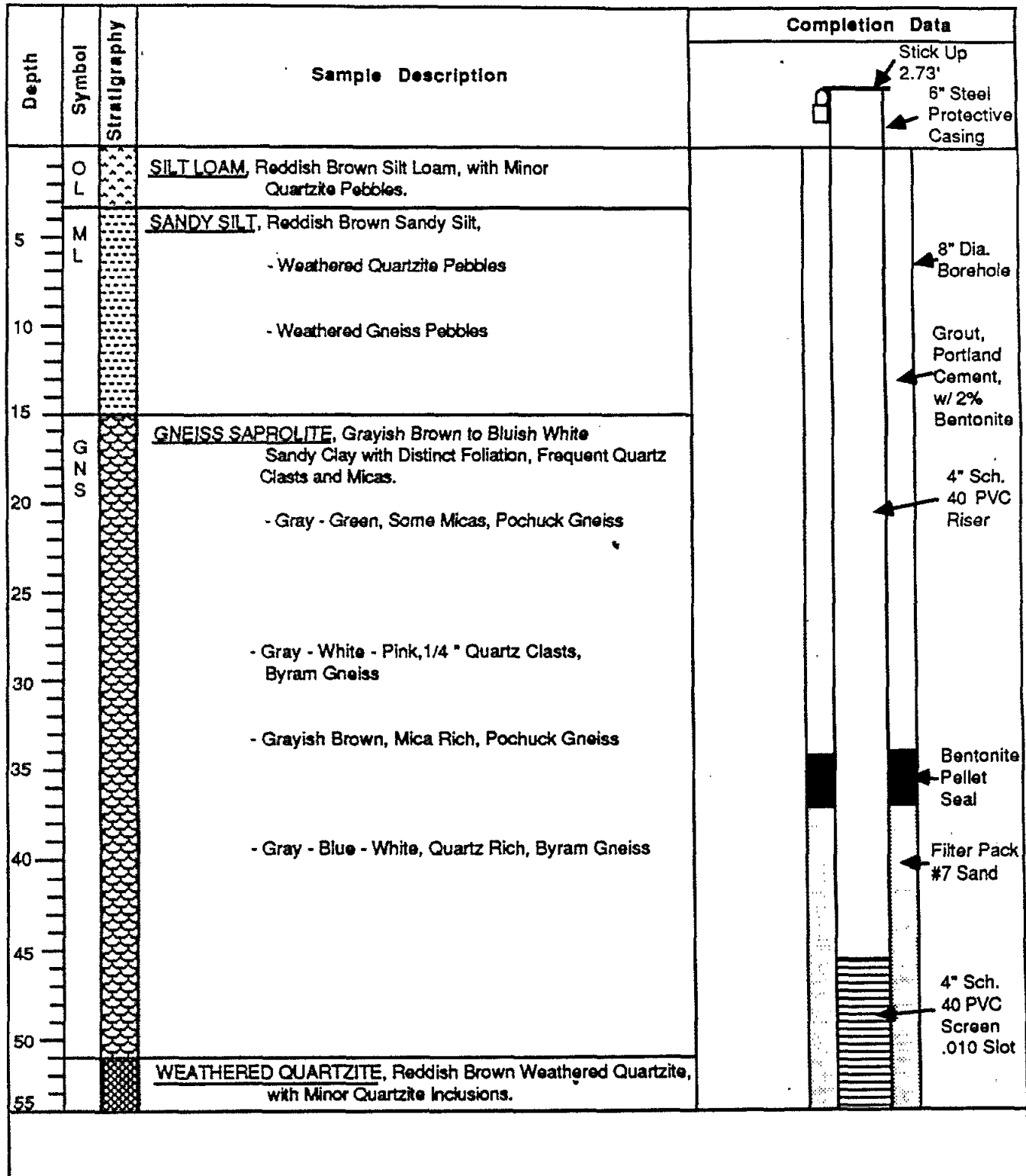
Site: Hereford Township

Elevation: Top of Steel Casing: 849.77

Total Depth: 58.97 TOC

Casing Size & Type: 4" I.D., SCH. 40 PVC

Screen Size: 10'-.010 Slot



AR100058

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 17 DEC 87

Well No.: 108


Site: Hereford Township

Elevation: Top of Steel Casing: 849.77

Total Depth: 58.97 TOC

Casing Size & Type: 4" I.D., SCH. 40 PVC

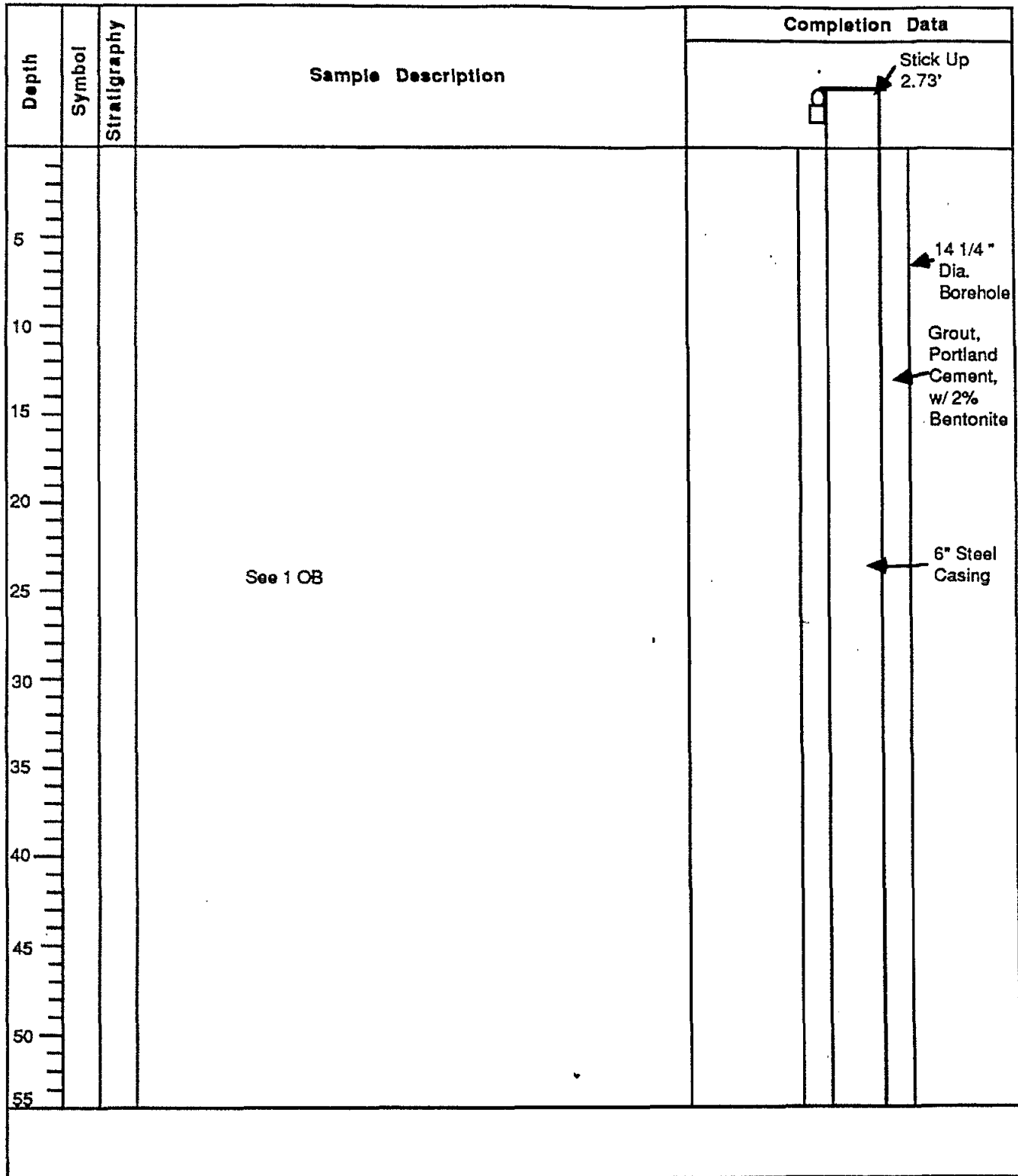
Screen Size: 10'-0.10 Slot

Depth	Symbol	Stratigraphy	Sample Description	Completion Data
60			Boring Terminated at 59.5'.	

AR100059

# MONITOR WELL INSTALLATION

Client: EPA-ERT      Job No.: 1014      Date Drilled: 1 March 1988      Well No.: 1R  
 Site: Hereford Township      Elevation: Top of Steel Casing: 849.34'  
 Total Depth: 164.87' TOC      Casing Size & Type: 6" Welded Steel      Screen Size: None



AR100060

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 1 March 1988

Well No.: 1R

Site: Hereford Township

Elevation: Top of Steel Casing: 849.34'

Total Depth: 164.87' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data			
60		Q T Z	<u>WEATHERED QUARTZITE</u> , Grayish-Tan Weathered Quartzite, with Strong Iron Staining, and Numerous Clay Seams				Grout, Portland Cement, w/2% Bentonite
65							
70							
75							
80							
85							
90							
95							
100							
105							
110			<u>QUARTZITE</u> , Buff to Gray Quartzite, Fine Grained, High Grade Metamorphism.				6" Steel Casing

AR100061

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 1 March 1988

Well No.: 1R

Site: Hereford Township

Elevation: Top of Steel Casing: 849.34'

Total Depth: 164.87' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data			
115			Well Fractured, with Numerous High Angle Fractures (~ 70%). Fractured Zones are Highly Weathered.				
120			- 4" Clay Seam.				
125			- Very Highly Fractured Quartzite, Low Grade Metamorphism, Distinct Medium to Coarse Quartz Grains. Intact Fracture Planes Contain Black Graphite Deposits. Slight Iron Staining.				Grout, Portland Cement, w/ 2% Bentonite
130	C H A						
135							
140			- Clays in Fractures Partially Lithified to Foliated Mudstone.				Grout, Portland Cement, w/ 5% Bentonite
145			- Light to Dark Gray Quartzite, Very Fine Grained, Highly Metamorphosed.				
150							
155			- Reddish Brown Fault Breccia.				
160			- Dark Gray Quartzite.				5 5/8" Dia. Open Borehole
165			- Black Quartzite, with High Angle Fractures.				
			Boring Terminated at 162.14'.				

AR100062

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 15 MAR 88

Well No.: 1.1 OB

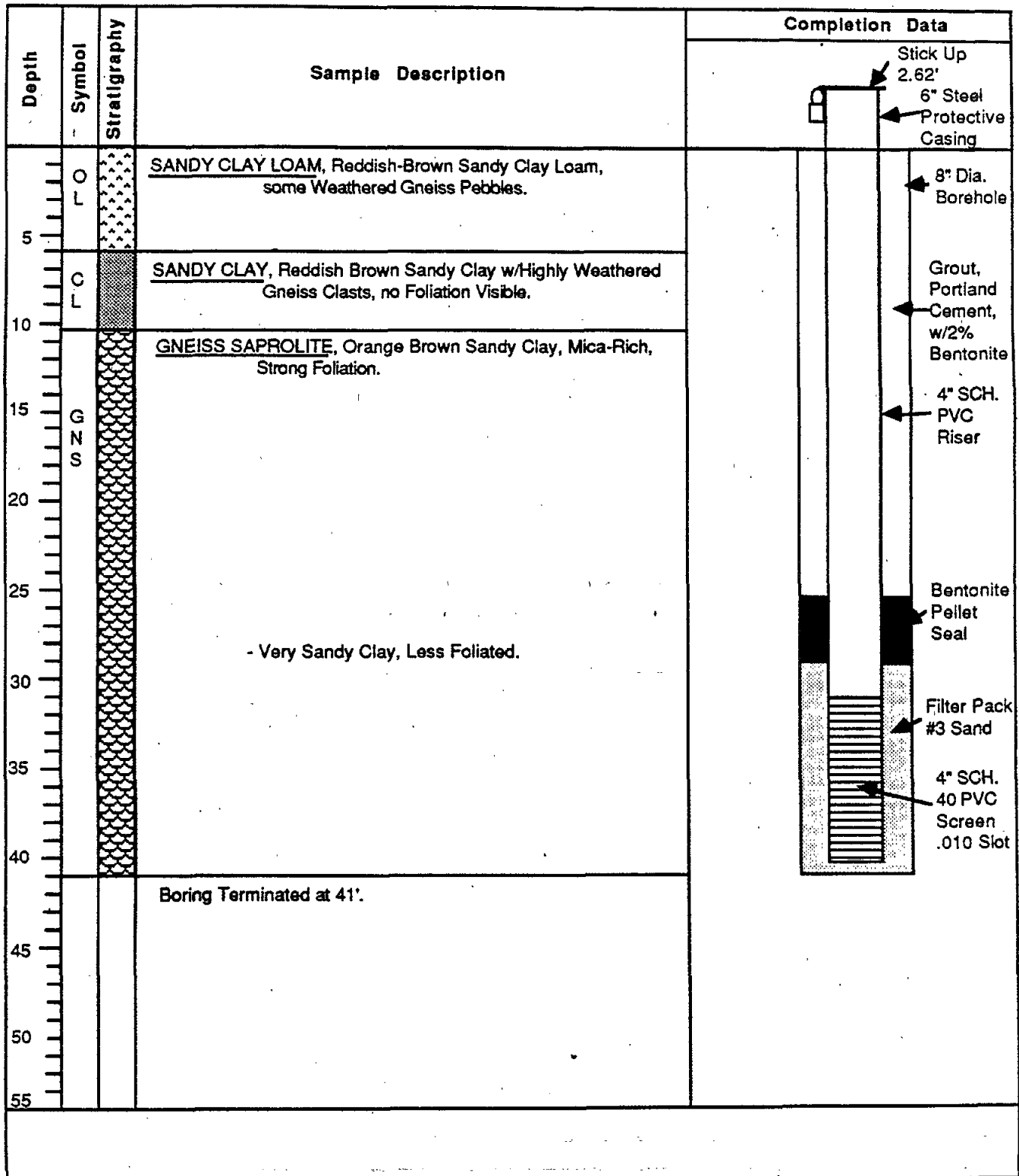
Site: Hereford Township

Elevation: Top of Steel Casing: 847.60

Total Depth: 43.13 TOC

Casing Size & Type: 4" SCH. 40 PVC

Screen Size: 10'-.010 Slot



AR100063

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 16 MAR 88

Well No.: 1.2 OB

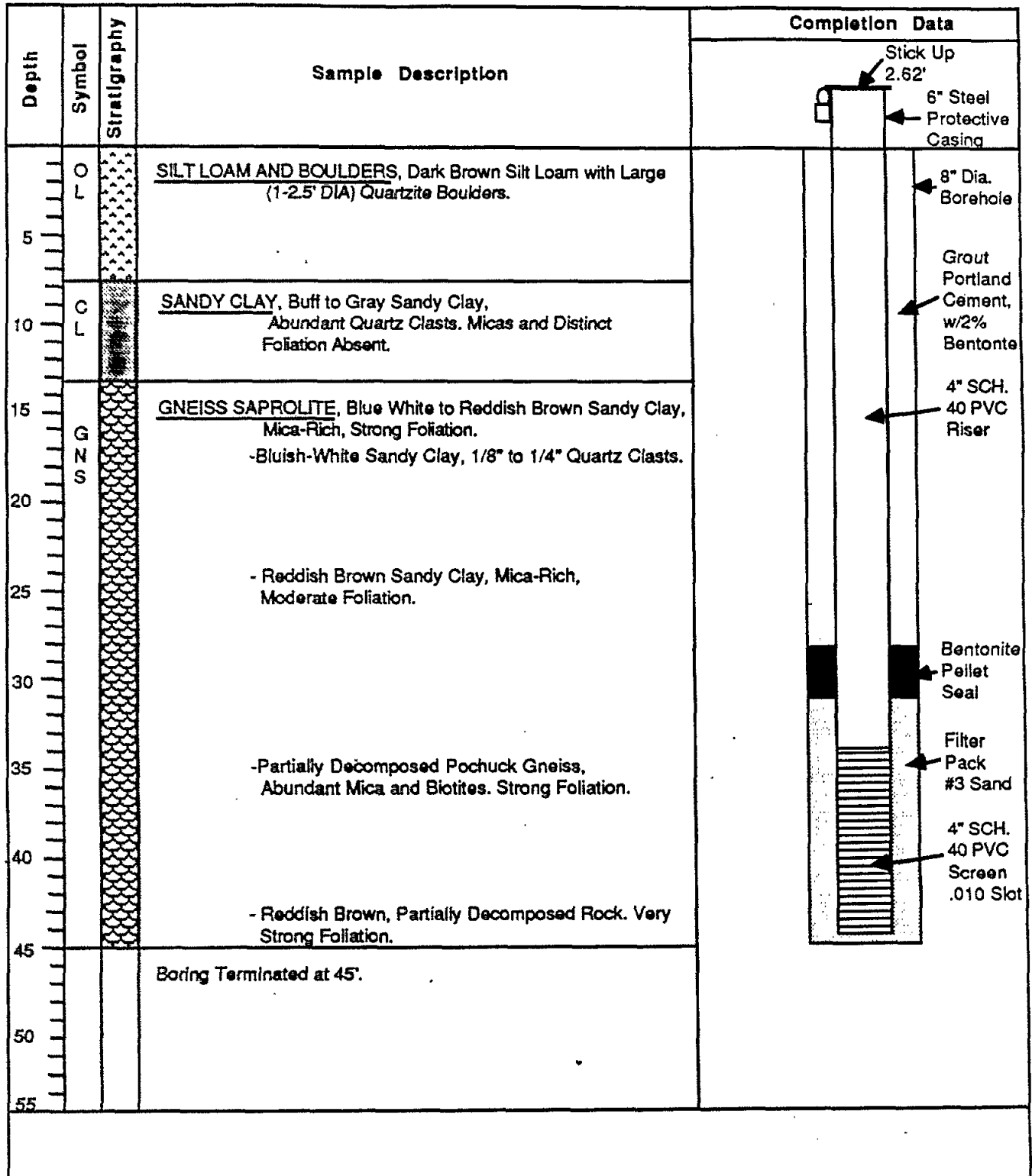
Site: Hereford Township

Elevation: Top of Steel Casing: 892.99

Total Depth: 46.67 TOC

Casing Size & Type: 4" SCH. 40 PVC

Screen Size: 10'-.010 Slot



AR100064



# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 19 APR 88

Well No.: 2 OB

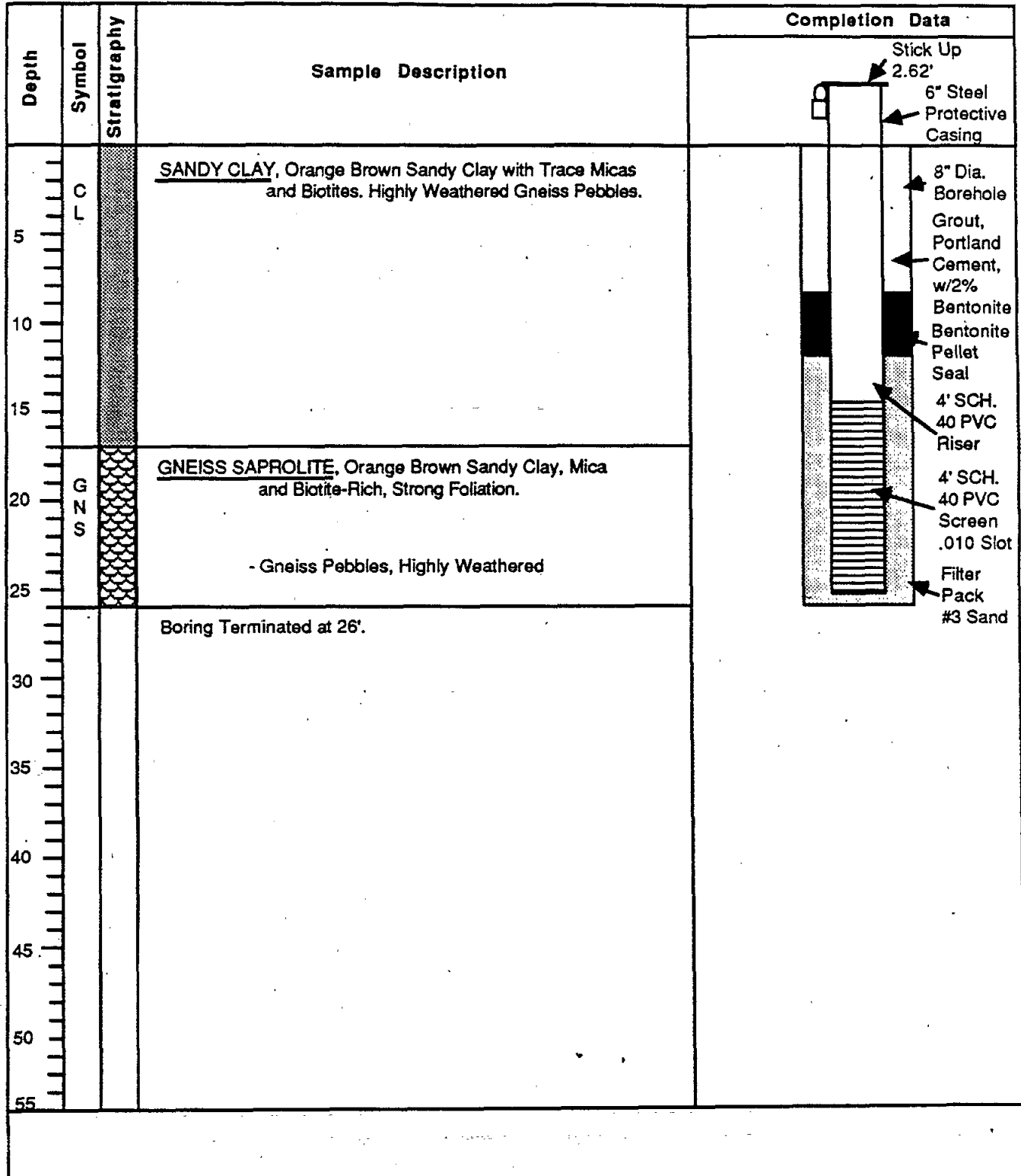
Site: Hereford Township

Elevation: Top of Steel Casing: 891.71

Total Depth: 27.38' TOC

Casing Size & Type: 4" SCH. 40 PVC

Screen Size: 10'-.010 Slot



AR100065

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 3 March 1988

Well No.: 2R

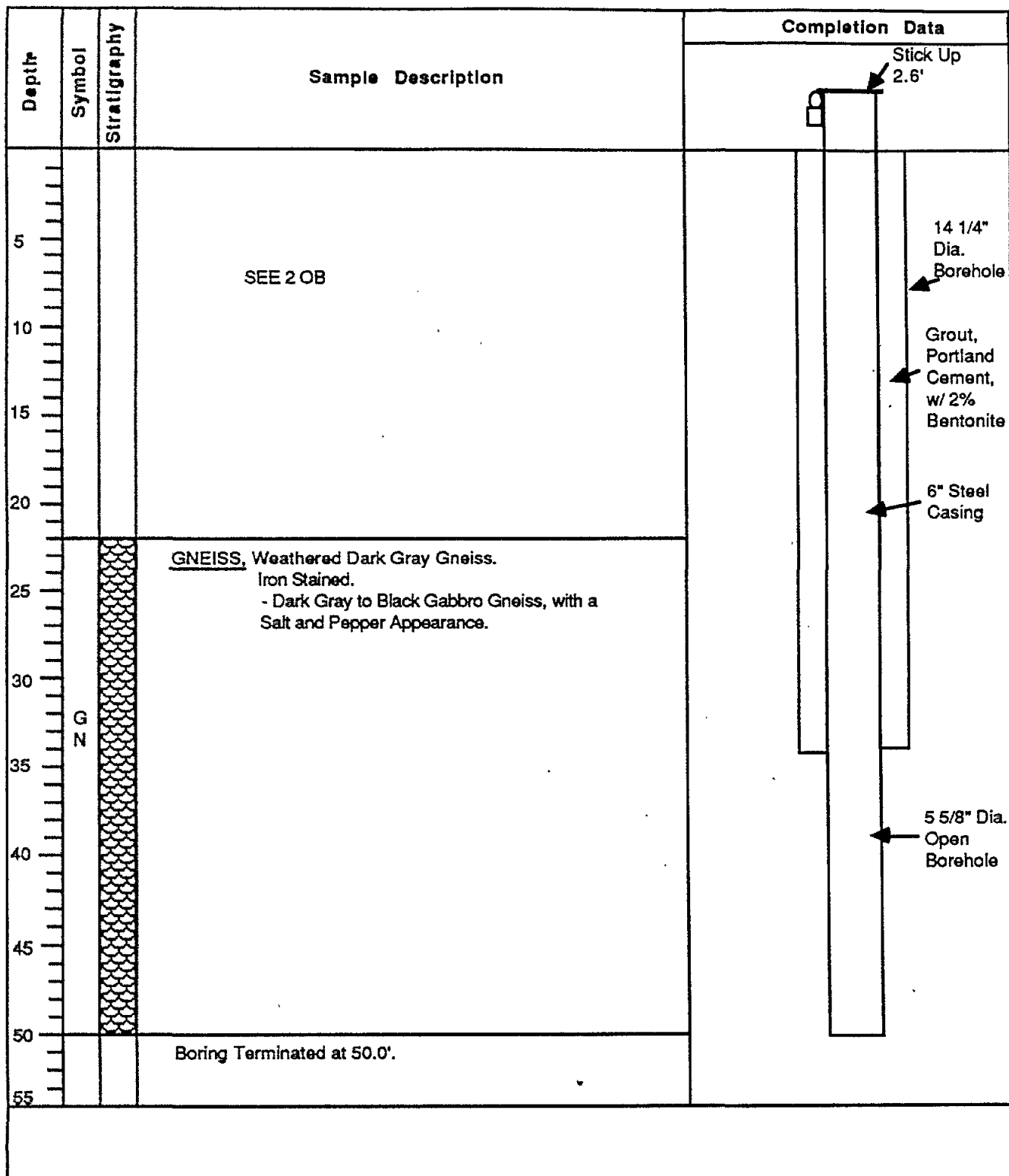
Site: Hereford Township

Elevation: Top of Steel Casing: 892.19

Total Depth: 52.6' TOC

Casing Size & Type: 6" Welded Steel

Screen Size: None



AR100066

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 22-24 March 1988 Well No.: 2DR

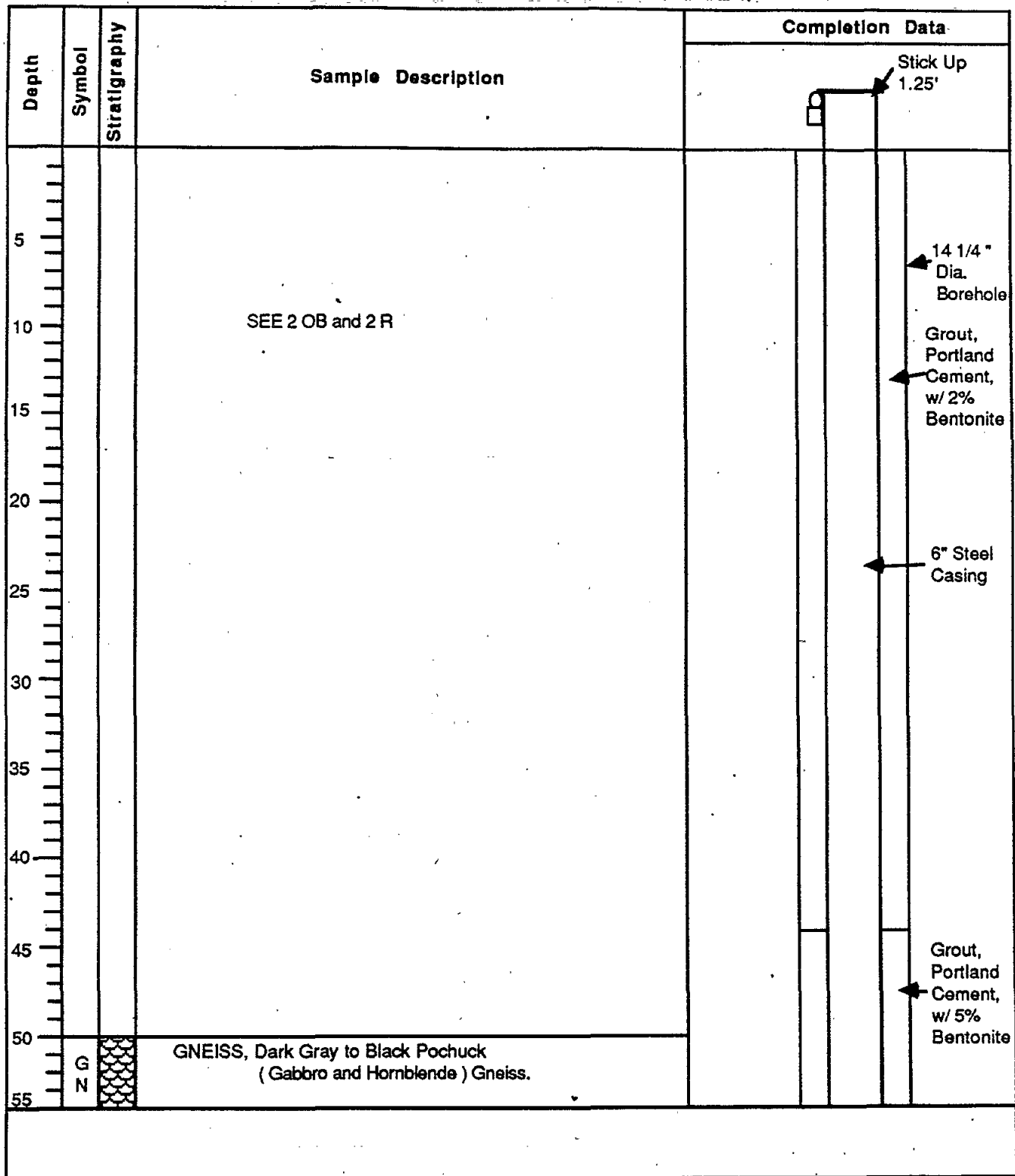
Site: Hereford Township

Elevation: Top of Steel Casing: 890.88'

Total Depth: 306.25'

Casing Size & Type: 6" Welded Steel

Screen Size: None



AR100067

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 22-24 March 1988 Well No.: 2DR

Site: Hereford Township

Elevation: Top of Steel Casing: 890.88

Total Depth: 306.25' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data		
60		Z G	Salt and Pepper Appearance Throughout, the Major Distinguishing Feature is the more Foliated Nature of the Hornblende Gneiss.			
65						
70						
75						
80						
85						
90						
95						
100						
105						
110						
			- Small Non-productive Fracture Zone.			

AR100068

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 22-24 March 1988 Well No.: 2 DR

Site: Hereford Township

Elevation: Top of Steel Casing: 890.88'

Total Depth: 306.25' TOC Casing Size & Type: 6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data		
115			<u>GNEISS</u> , Dark Gray to Black Pochuck Gneiss. No Productive Fractures.			
120						
125						
130						
135						
140						
145						
150						
155						
160						
165						

5 5/8" Dia.  
Open  
Borehole

AR100069

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 22-24 March 1988 Well No.: 2DR

Site: Hereford Township

Elevation: Top of Steel Casing: 890.88'

Total Depth: 306.25' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data		
225		N G	<u>GNEISS</u> , Dark Gray to Black Pochuck Gneiss. No Productive Fractures.			
230						
235						
240						
245						
250						
255						
260						
265						
270						
275						

5 5/8' Dia.  
Open  
Borehole

AR100070

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 22-24 March 1988 Well No.: 2 DR

Site: Hereford Township

Elevation: Top of Steel Casing: 890.88'

Total Depth: 306.25' TOC Casing Size & Type: 6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data	
280		G N	<u>GNEISS</u> , Dark Gray to Black Pochuck Gneiss. No Productive Fractures.		5 5/8" Dia. Open Borehole
285					
290					
295					
300					
305			Boring Terminated at 305'.		
310					

AR100071

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 17 MAR 88

Well No.: 2.1 OB

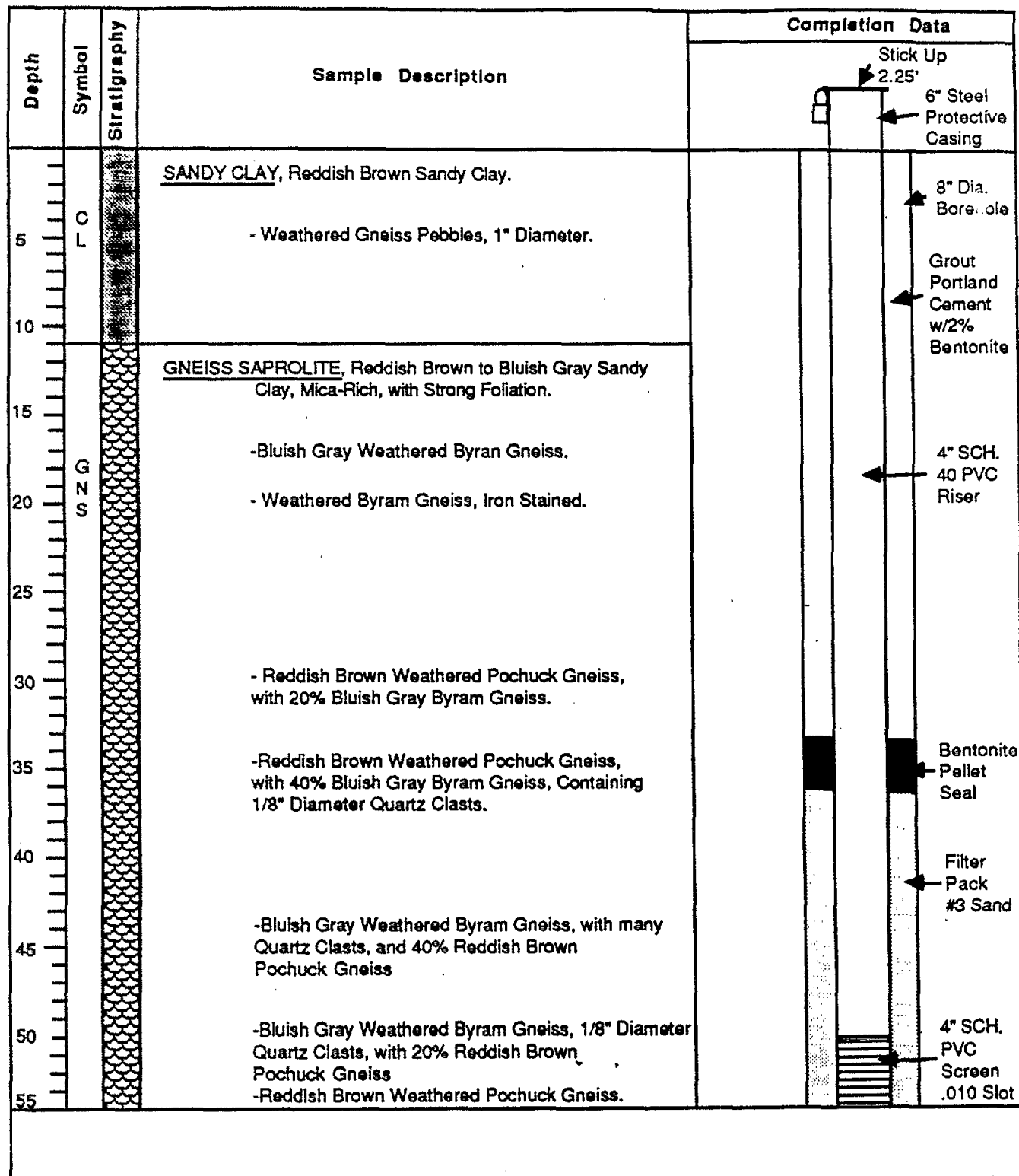
Site: Hereford Township

Elevation: Top of Steel Casing: 933.83

Total Depth: 62.08' TOC

Casing Size & Type: 4" SCH. 40 PVC

Screen Size: 10'-.010 SLOT



AR100072



# **MONITOR WELL INSTALLATION**

**Client:** EPA-ERT

**Job No.:** 1014

**Date Drilled:** 17 DEC 87

**Well No.:** 2.1 OB


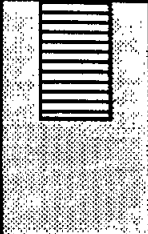
**Site:** Hereford Township

**Elevation: Top of Steel Casing:** 933.83

**Total Depth:** 62.08' TOC

**Casing Size & Type:** 4", SCH. 40 PVC

**Screen Size:** 10'-010 Slot

Depth	Symbol	Stratigraphy	Sample Description	Completion Data
60	G N S		-Reddish Brown Weathered Pochuck Gneiss.	
			Boring Terminated at 65'.	

AR100073

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 12 JAN 88

Well No.: 3 OB

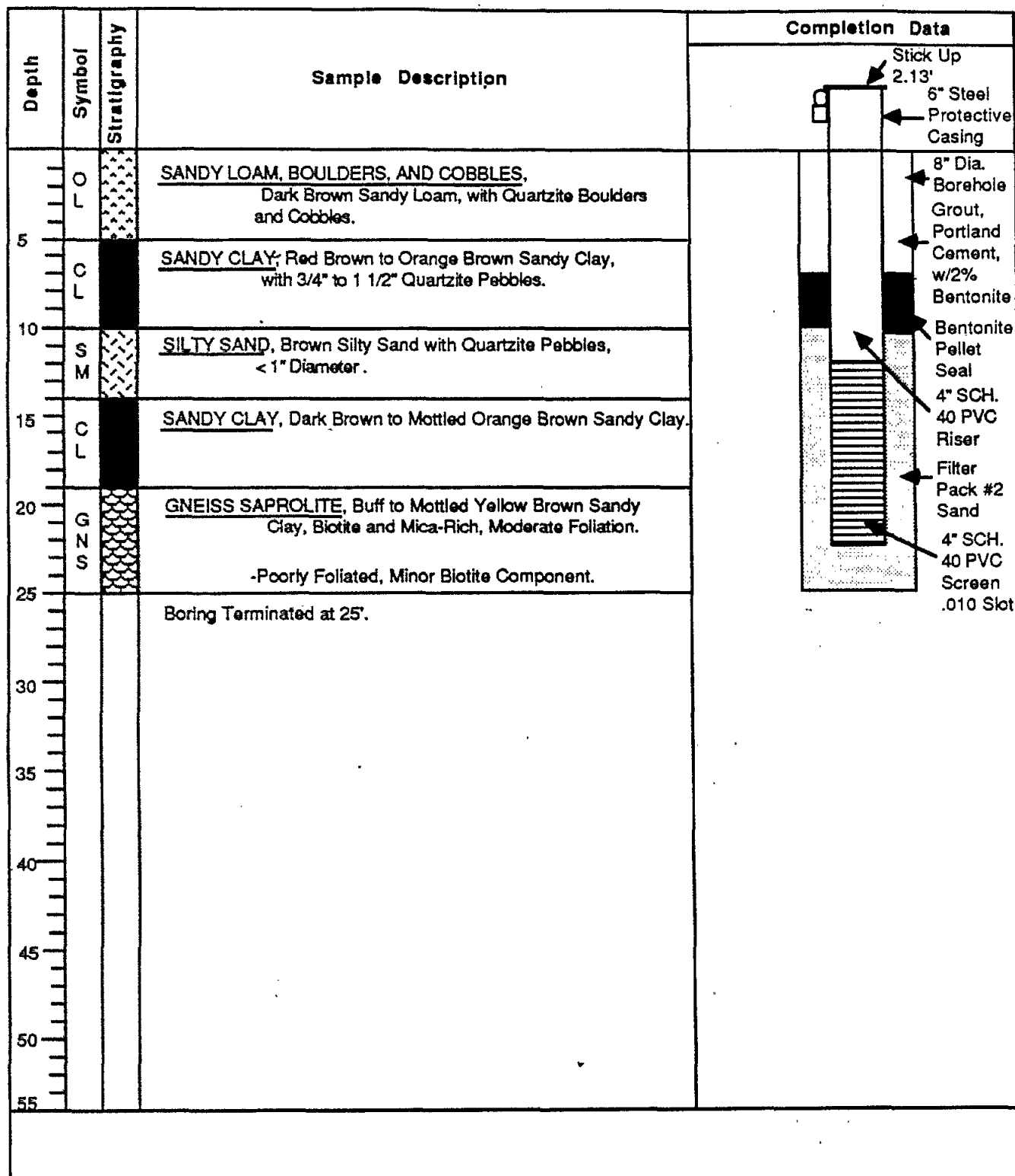
Site: Hereford Township

Elevation: Top of Steel Casing: 701.73

Total Depth: 24.78' TOC

Casing Size & Type: 4", SCH. 40 PVC

Screen Size: 10'-.010 Slot



AR100074

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 7-8 JAN 88

Well No.: 3 DOB

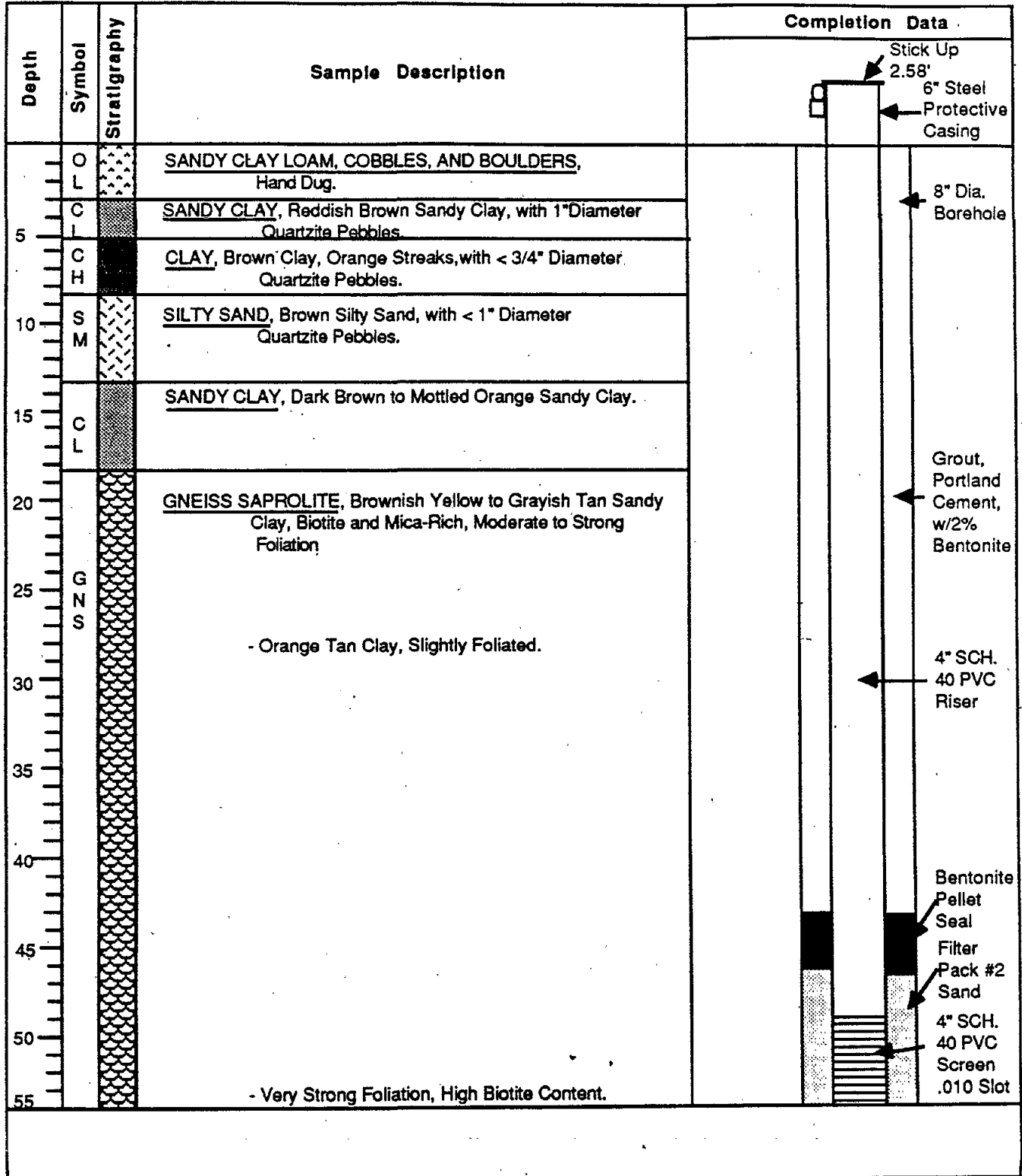
Site: Hereford Township

Elevation: Top of Steel Casing: 706.81

Total Depth: 72.35' TOC

Casing Size & Type: 4" SCH. 40 PVC

Screen Size: 20'-.010 Slot Slot



AR100075

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 7-8 Jan 88

Well No.: 3 DOB


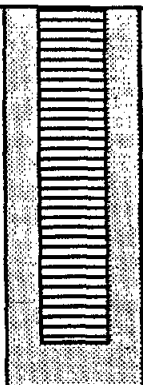
Site: Hereford Township

Elevation: Top of Steel Casing: 706.81

Total Depth: 72.35' TOC

Casing Size & Type: 4", SCH. 40 PVC

Screen Size: 20'-.010 Slot

Depth .	Symbol	Stratigraphy	Sample Description	Completion Data
55				
60	G Z S		- Mottled Orange Brown Clay, Less Foliated.	
65				
70				
75				
80			Boring Terminated at 71.5'.	
85				
90				
95				
100				
105				
110				

AR100076

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 5 JAN 88

Well No.: 4 OB

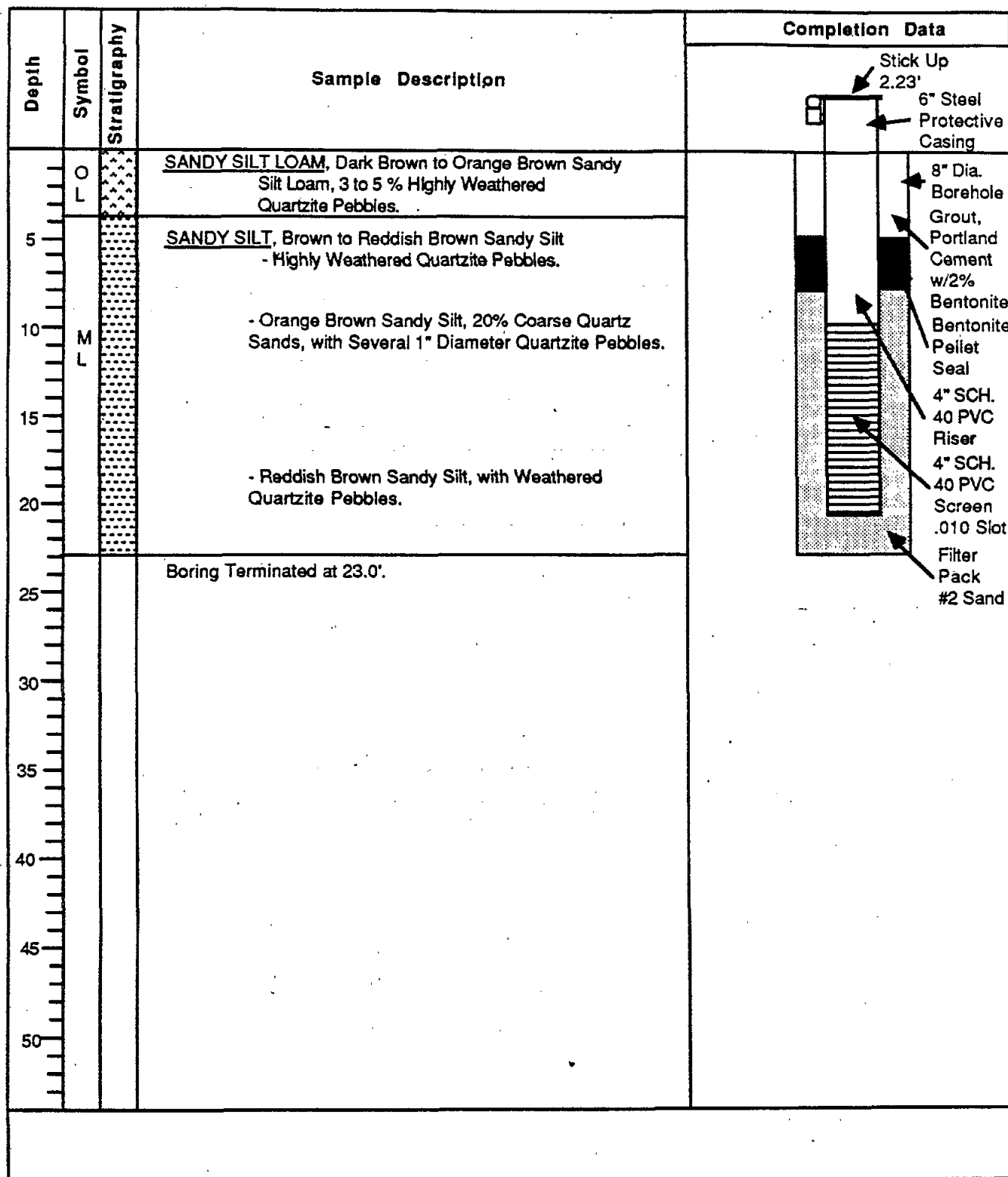
Site: Hereford Township

Elevation: Top of Steel Casing: 680.55

Total Depth: 23.65' TOC

Casing Size & Type: 4" SCH. 40 PVC

Screen Size: 10'-.010 Slot



AR100077

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 8-13 April 1988

Well No.: 4R

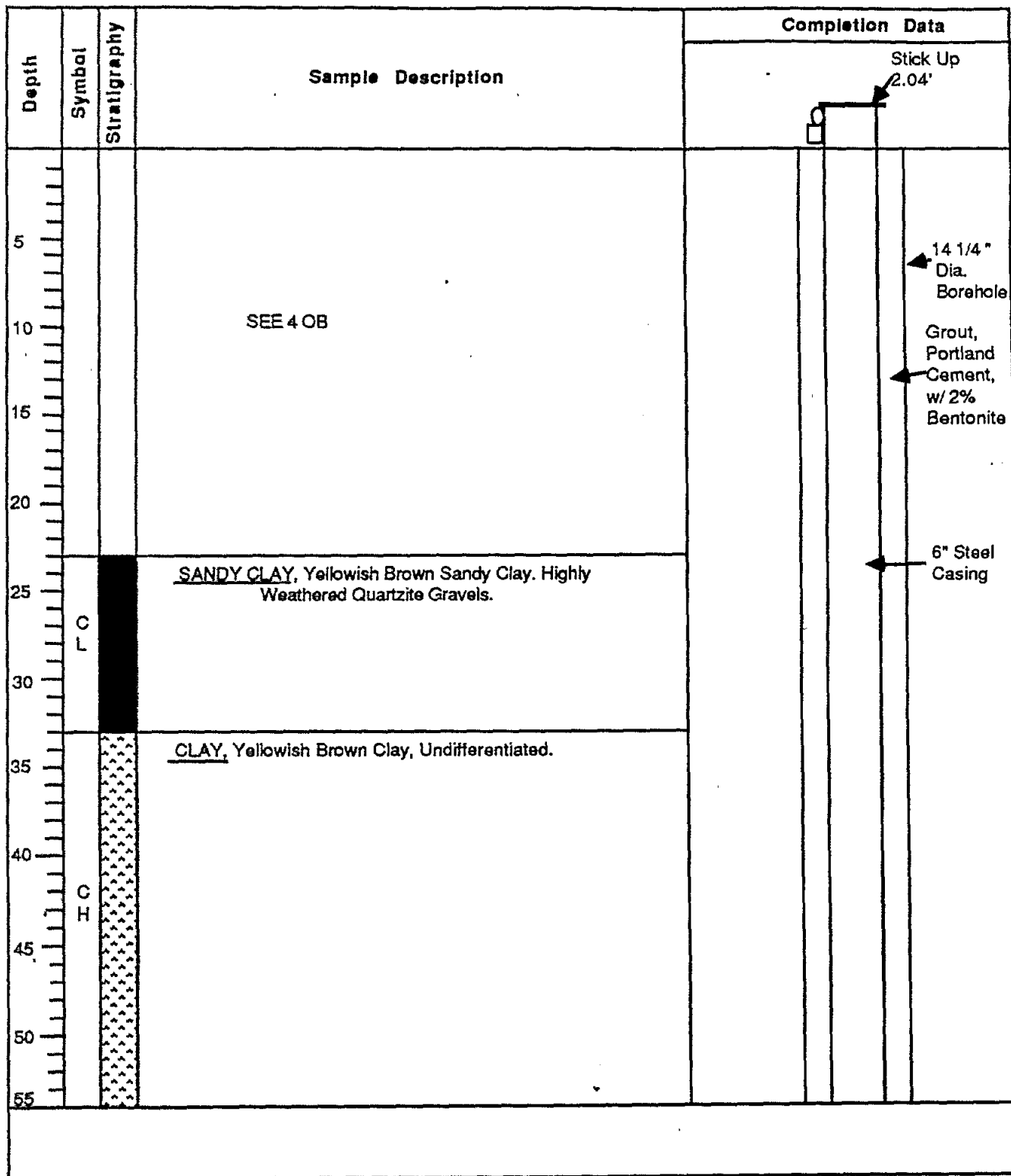
Site: Hereford Township

Elevation: Top of Steel Casing: 682.21'

Total Depth: 239.5' TOC

Casing Size & Type: 6" Welded Steel

Screen Size: None



AR100078

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 8-13 April 1988

Well No.: 4R


Site: Hereford Township

Elevation: Top of Steel Casing: 682.21

Total Depth: 239.5' TOC

Casing Size & Type: 6" Welded Steel

Screen Size: None

				Completion Data					
Depth	Symbol	Stratigraphy	Sample Description						
60	C H		<u>CLAY</u> , Yellowish Brown Clay, Undifferentiated				Grout, Portland Cement, w/2% Bentonite		
65									
70									
75									
80									
85									
90									
95									
100								C H A	<u>QUARTZITE</u> , Orange Brown Quartzite Gravels. Probable Float.
105								C H	<u>CLAY</u> , Yellow Brown Clay, Undifferentiated. Very Stiff, Almost Dry.
110									

Grout,  
Portland  
Cement,  
w/2%  
Bentonite

6" Steel  
Casing

AR100079

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 8-13 April 1988

Well No.: 4R

Site: Hereford Township

Elevation: Top of Steel Casing: 682.21'

Total Depth: 239.5' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data			
115	C H						
120							
125							
130	C H		CLAY, Brownish Yellow Clay, Undifferentiated. Stiff.				Grout, Portland Cement, w/2% Bentonite        6" Steel Casing
135							
140							
145							
150							
155							
160							
165							

AR100080



# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 8-13 April 1988

Well No.: 4R

Site: Hereford Township

Elevation: Top of Steel Casing: 682.21'

Total Depth: 239.5' TOC

Casing Size & Type: 6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data				
170								
175								
180	C H							Grout, Portland Cement, w/2% Bentonite
185								
190								
195								
200			> Circulation Lost					6" Steel Casing
205	S M		<u>SILTY SAND</u> , Brown Silty Sand, Very Fine Grained.  - Very Fine Sandstone, With Shale Fragments. Moderately Weathered.					
210								
215	C H A		<u>QUARTZITE</u> , Light Buff to Light Gray, Frequently Iron-stained, Hardyston Quartzite Conglomerate. Dark Gray to Black, Very Fine-Grained Shales, Present at the top of the Formation					
220								

AR100081

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014




Date Drilled: 22-24 March 1988 Well No.: 4R

Site: Hereford Township

Elevation: Top of Steel Casing: 682.21'

Total Depth: 239.5' TOC Casing Size & Type: 6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data	
225	C H A		- Gray, Massive Quartzite.		5 5/8" Dia. Open Borehole
230			- 1' Clay Seam.		
235			- Gray, Massive Quartzite.		
240	C L V		CARBONATE, Light Gray to Brown Dirty Carbonate of the Leithsville Formation.		
245			Boring Terminated at 240'.		
250					

AR100082

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 22 DEC 87

Well No.: 5 OB

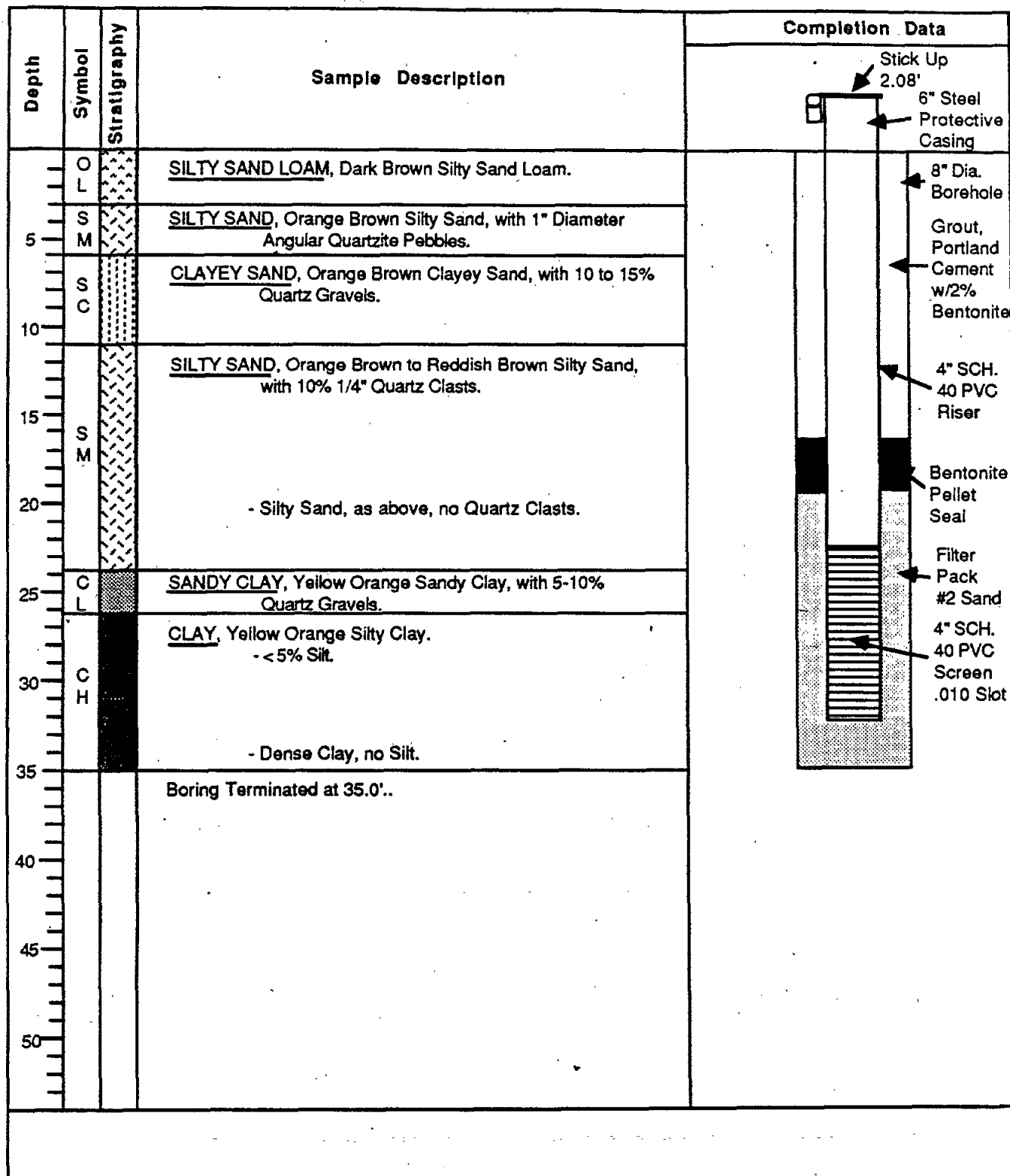
Site: Hereford Township

Elevation: Top of Steel Casing: 688.94

Total Depth: 34.54' TOC

Casing Size & Type: 4", SCH. 40 PVC

Screen Size: 10'-.010 Slot



AR100083

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 18-20 DEC 87

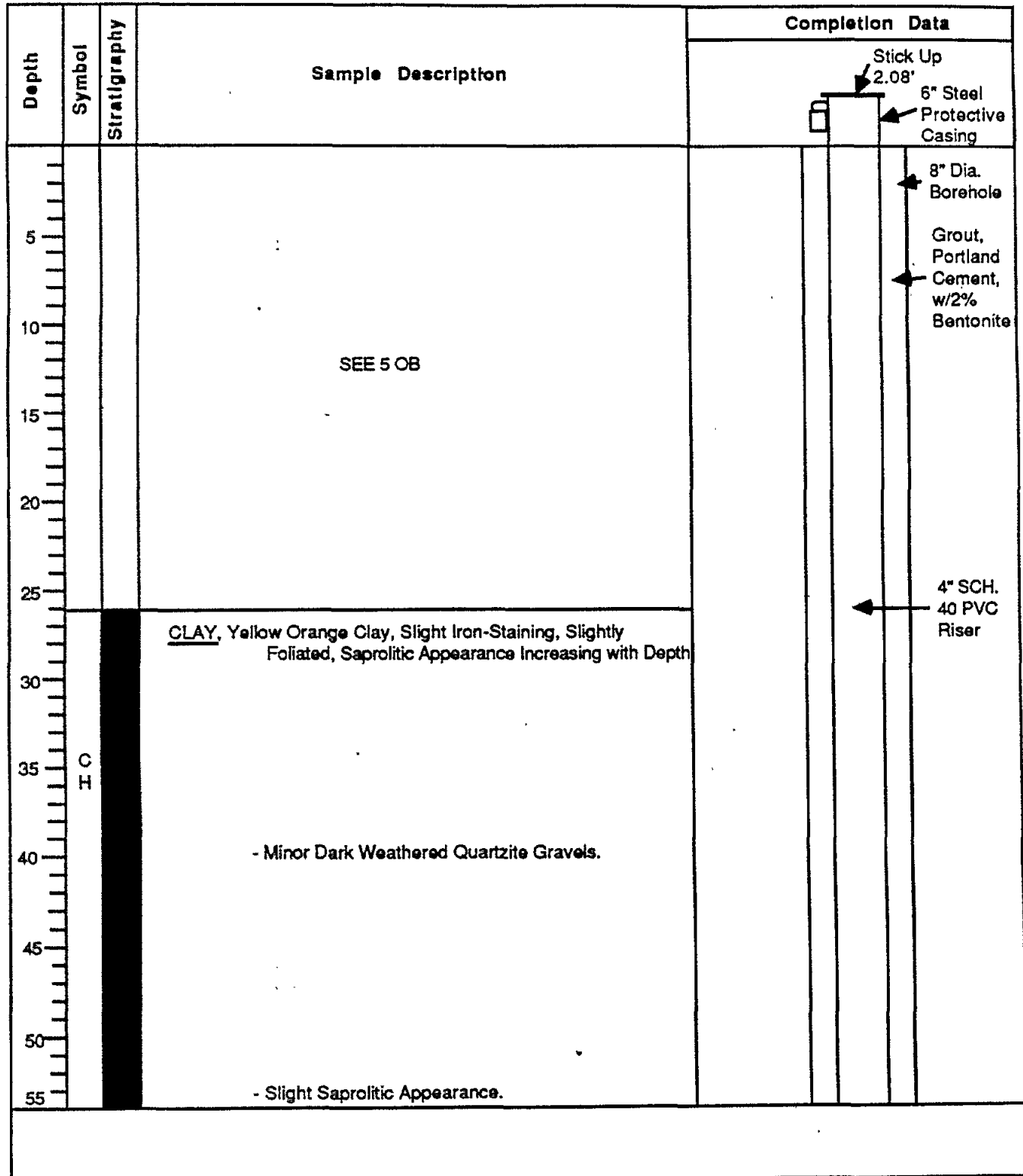
Well No.: 5 DOB

Site: Hereford Township

Elevation: Top of Steel Casing: 689.20

Total Depth: 105.08' TOC Casing Size & Type: 4" SCH. 40 PVC

Screen Size: 20"-0.010 Slot



AR100084

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 18-20 DEC 87

Well No.: 5 DOB

Site: Hereford Township

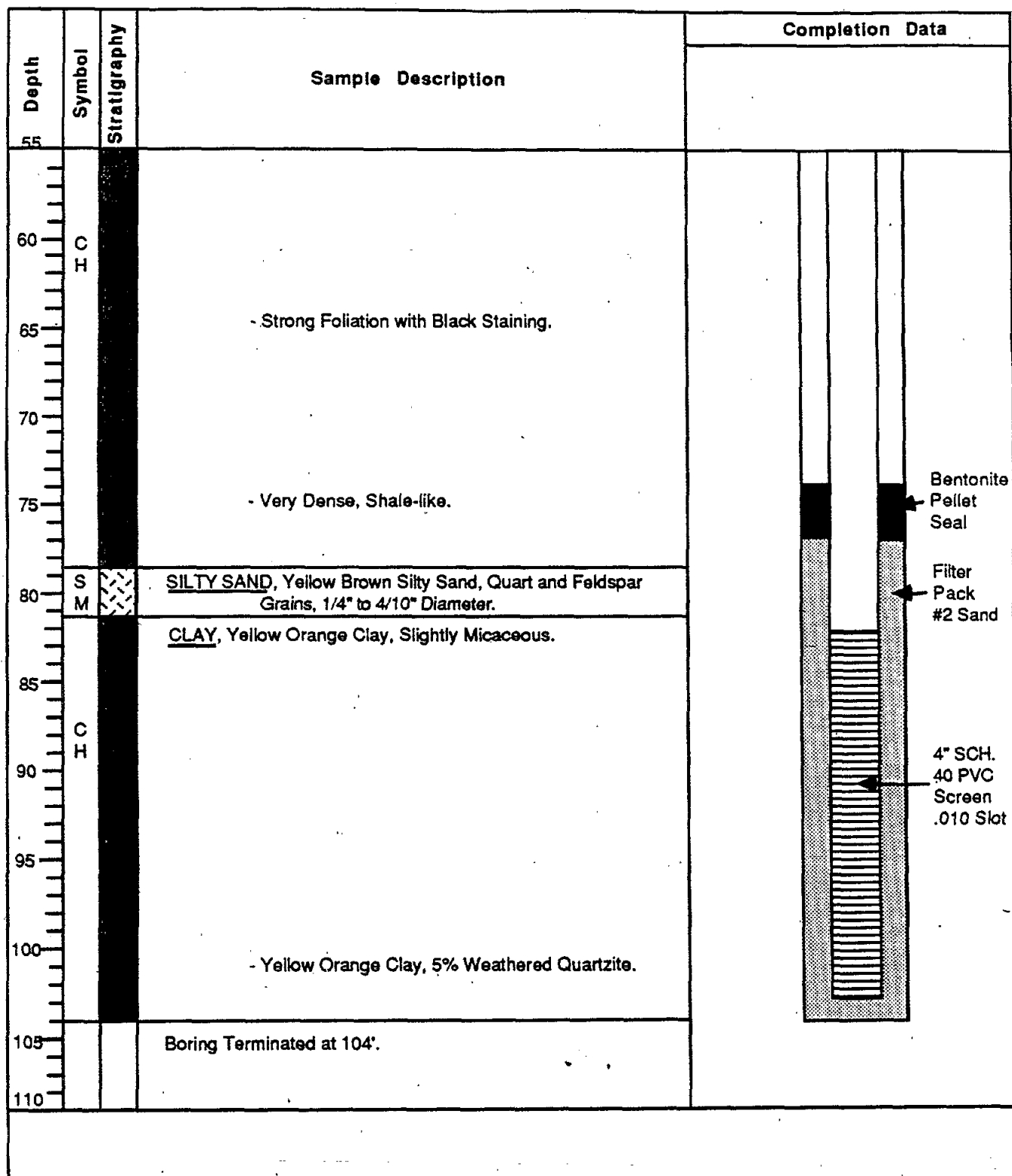
Elevation: Top of Steel Casing: 689.20

Total Depth: 105.08' TOC

Casing Size & Type:

4", SCH. 40 PVC

Screen Size: 20'-.010 Slot



AR100085

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 14-26 April 1988 Well No.: 5R

Site: Hereford Township

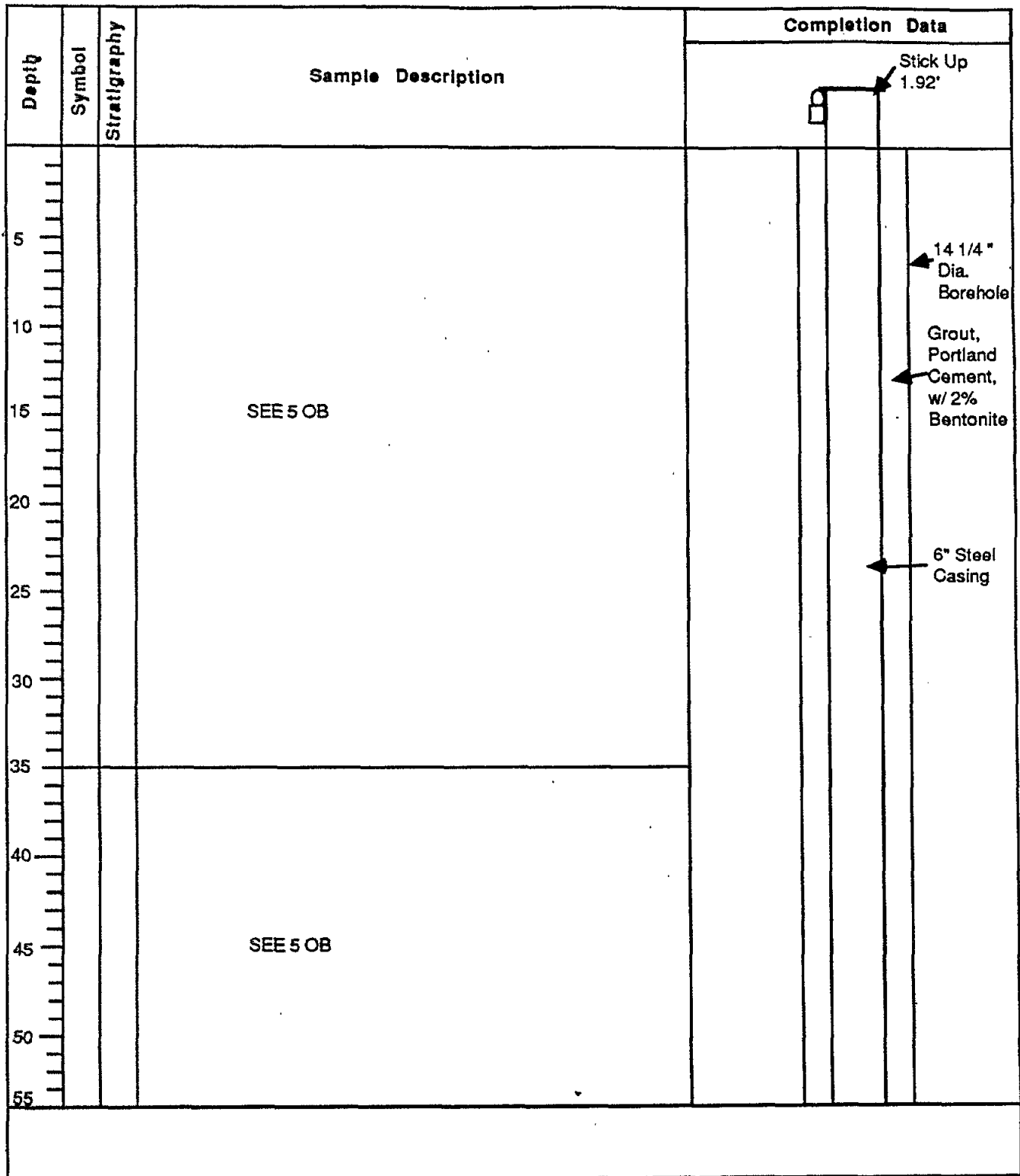
Elevation: Top of Steel Casing: 687.93'

Total Depth: 303.92' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None



AR100086

## MONITOR WELL INSTALLATION

**Client:** EPA-ERT

**Job No.:** 1014


Date Drilled: 14-26 April 1988 Well No.: 5B

**Site:** Hereford Township

Elevation: Top of Steel Casing: 687.93'

Total Depth: 303.92' TOC Casing Size & Type: 6" Welded Steel

**Screen Size:** None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data				
60			SEE 5 DOB					
65								
70								
75								
80								
85								
90								
95								
100								
105	C H			CLAY, Yellow to Brown Clay. Frequent Quartzite and Shale Fragments.				
110								

AR100087

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 14-26 April 1988

Well No.: 5R

Site: Hereford Township

Elevation: Top of Steel Casing: 687.93'

Total Depth: 303.92' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data			
115	CH		- Massive Quartzite Ledge.				
120			- Clay Seam. 118-121'. Very Soft.				
125			- Clay. Abundant Quartzite Fragments.				
130	SH		<u>SHALE</u> , Black to Dk. Brownish Red. Shales.				
135	CH		<u>CLAY</u> , Brownish Gray Clay. Undifferentiated.				
140							
145							
150			- Minor Quartzite and Shales.				
155			- Quartzite Ledge. 1-1 1/2' Thick.				
160							
165			- Weathered Quartzite.				

Grout,  
Portland  
Cement,  
w/2%  
Bentonite

6" Steel  
Casing

AR100088



## MONITOR WELL INSTALLATION

**Client:** EPA-ERT

**Job No.: 1014**

**Date Drilled:** 14-26 April 1988

**Well No.: 5R**

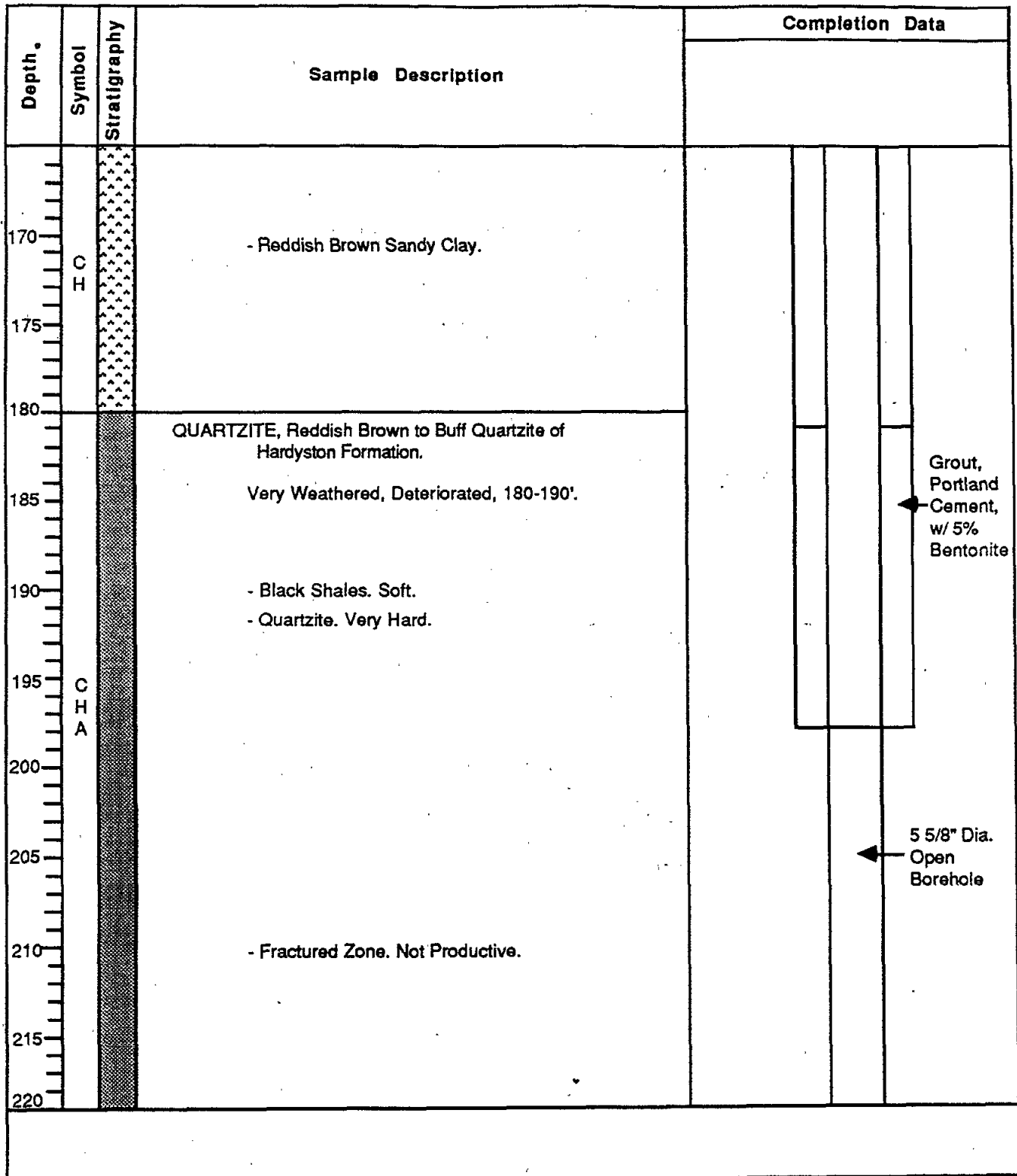
**Site:** Hereford Township

**Elevation: Top of Steel Casing: 687.93'**

**Total Depth: 303.92' TOC**

**Casing Size & Type:** 6" Welded Steel

**Screen Size:** None



AR100089

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 14-26 April 1988

Well No.: 5R

Site: Hereford Township

Elevation: Top of Steel Casing: 687.93'

Total Depth: 303.92' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data		
225						
230						
235						
240						
245						
250						
255						
260						
265						
270						
275						

CARBONATE, Black Massive Carbonate.  
Strong Sulfur Odor.

QUARTZITE, Dark Gray to Black Quartzite.  
- Fracture. 1 gpm.

- Black Quartzite.

- Gray Quartzite.

- Grayish Brown Quartzite.

5 5/8" Dia.  
Open  
Borehole

AR100090

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 14-26 April 1988

Well No.: 5R

Site: Hereford Township

Elevation: Top of Steel Casing: 687.93'

Total Depth: 303.92' TOC

Casing Size & Type: 6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data		
280			- Black Quartzite, Very Fine Grained.			
285			- Gray Vitreous Quartzite. Individual Grains are Not Distinguishable. Almost Pure Quartz.			
290						
295						
300						
305			Boring Terminated at 302'.			
310						

← 5 5/8" Dia.  
Open  
Borehole

AR100091

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 21 DEC 87

Well No.: 6 OB

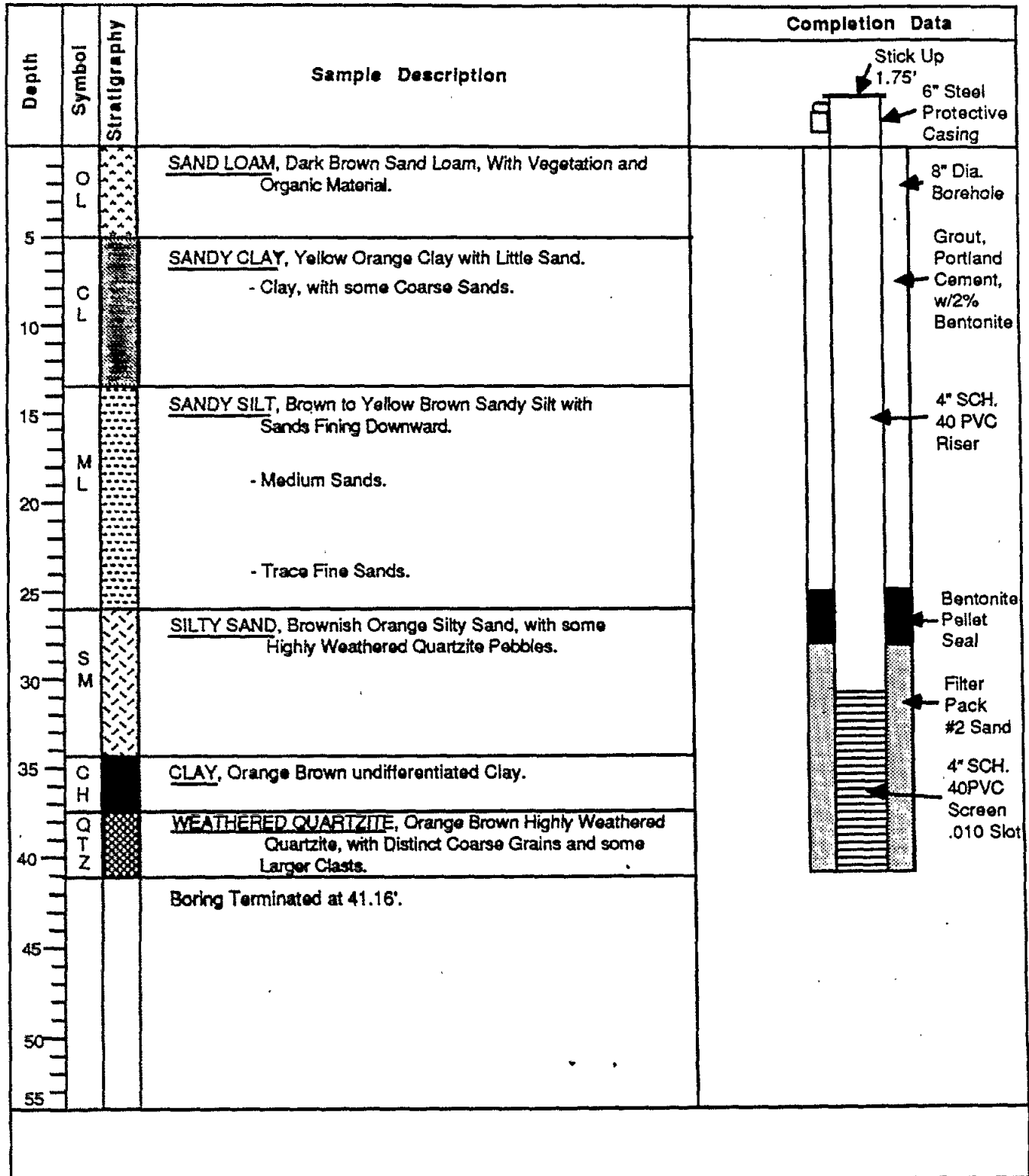
Site: Hereford Township

Elevation: Top of Steel Casing: 646.39

Total Depth: 42.75' TOC

Casing Size & Type: 4", SCH. 40 PVC

Screen Size: 10'-.010 Slot



AR100092

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 27-28 April 1988

Well No.: 6R

Site: Hereford Township

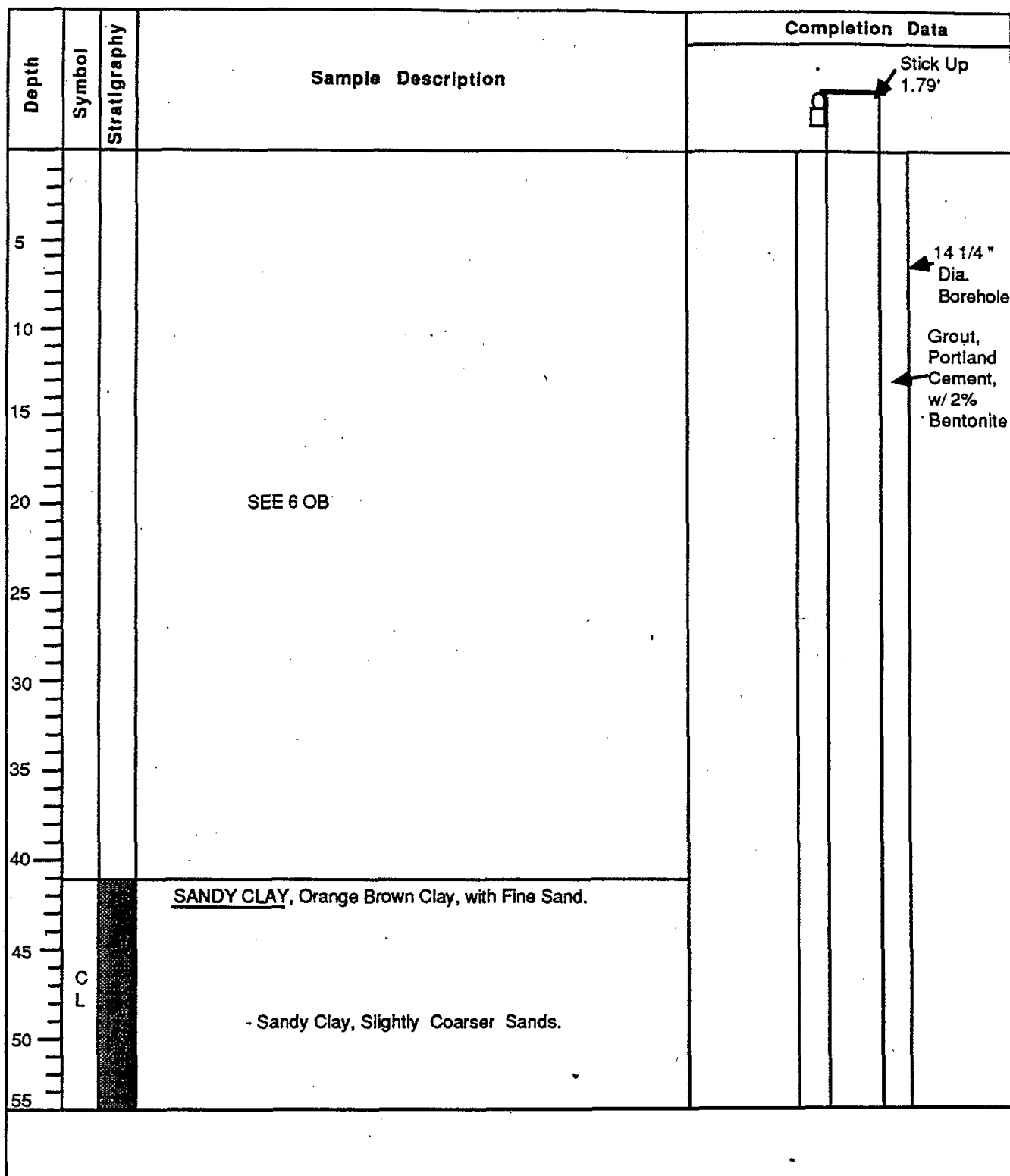
Elevation: Top of Steel Casing: 646.29'

Total Depth: 102.79' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None



AR100093

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 27-28 April 1988

Well No.: 6R

Site: Hereford Township

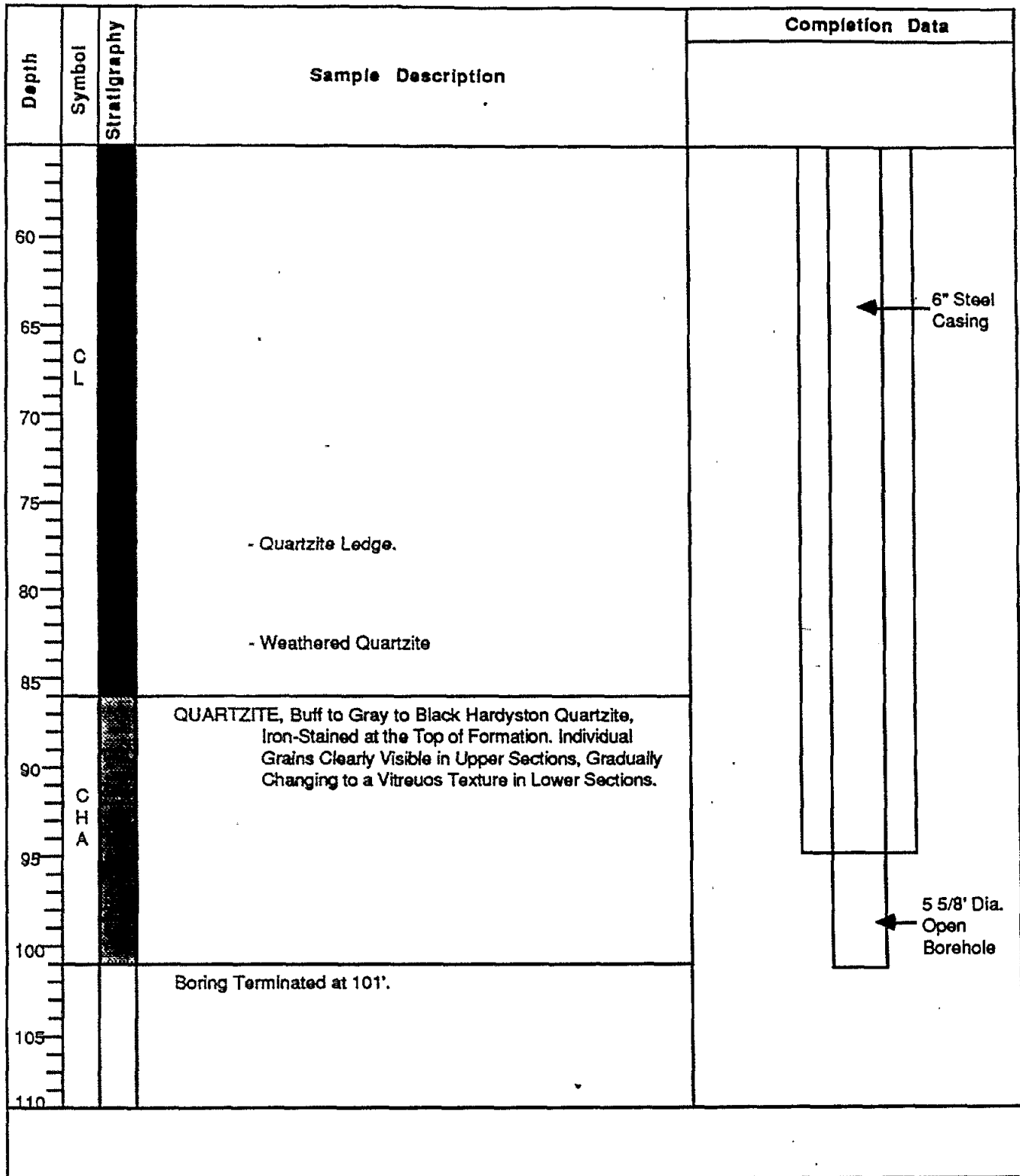
Elevation: Top of Steel Casing: 646.29'

Total Depth: 102.79' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None



AR100094

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 13-14 JAN 88

Well No.: 7 OB

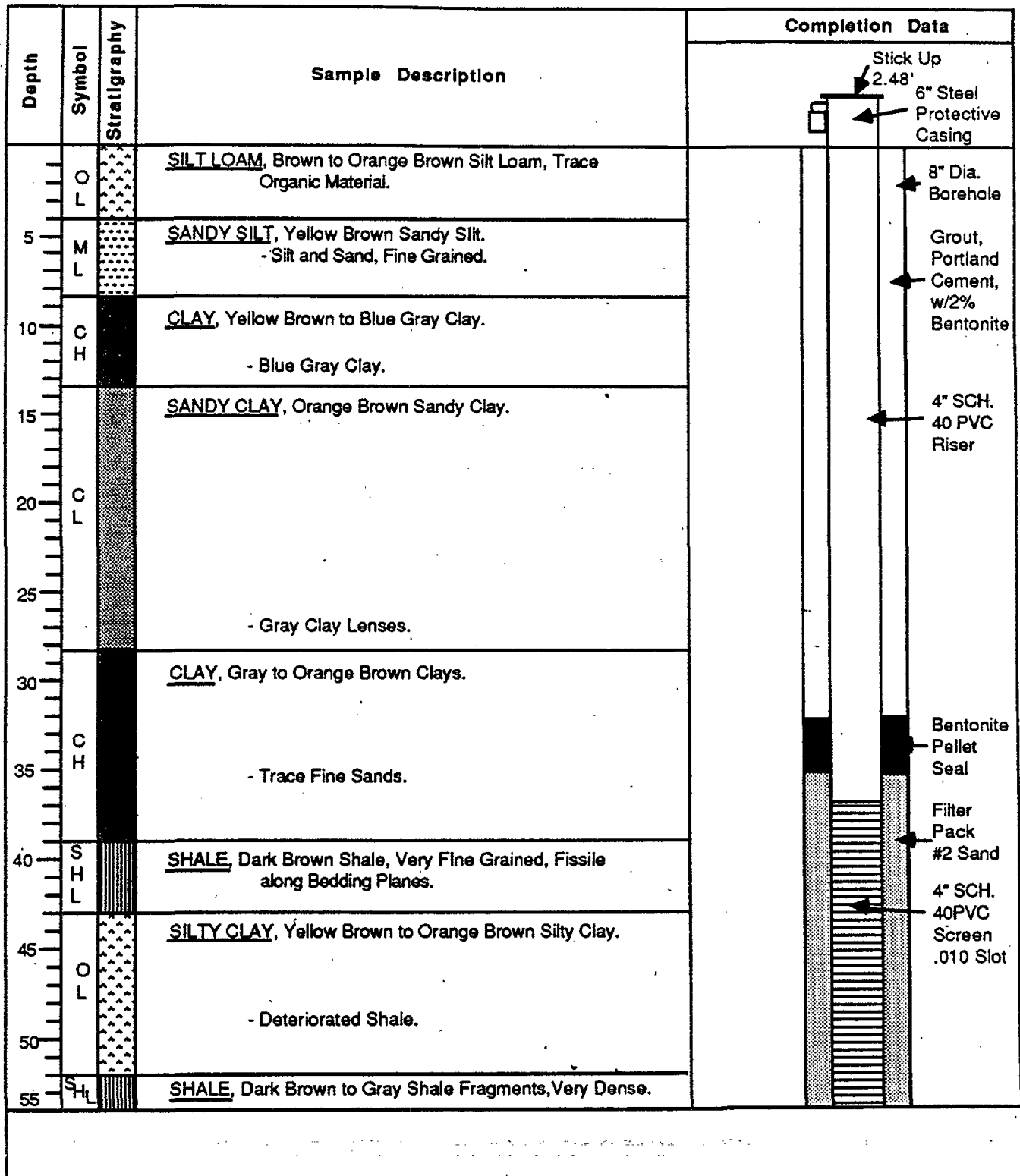
Site: Hereford Township

Elevation: Top of Steel Casing: 645.12

Total Depth: 58.94' TOC

Casing Size & Type: 4", SCH. 40 PVC

Screen Size: 20'-.010 Slot



AR100095

Well No.: 7 OB

**Elevation: Top of Steel Casing: 645.12**

**Screen Size:** 20', .010 Slot





# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 28 March 1988

Well No.: 7R

Site: Hereford Township

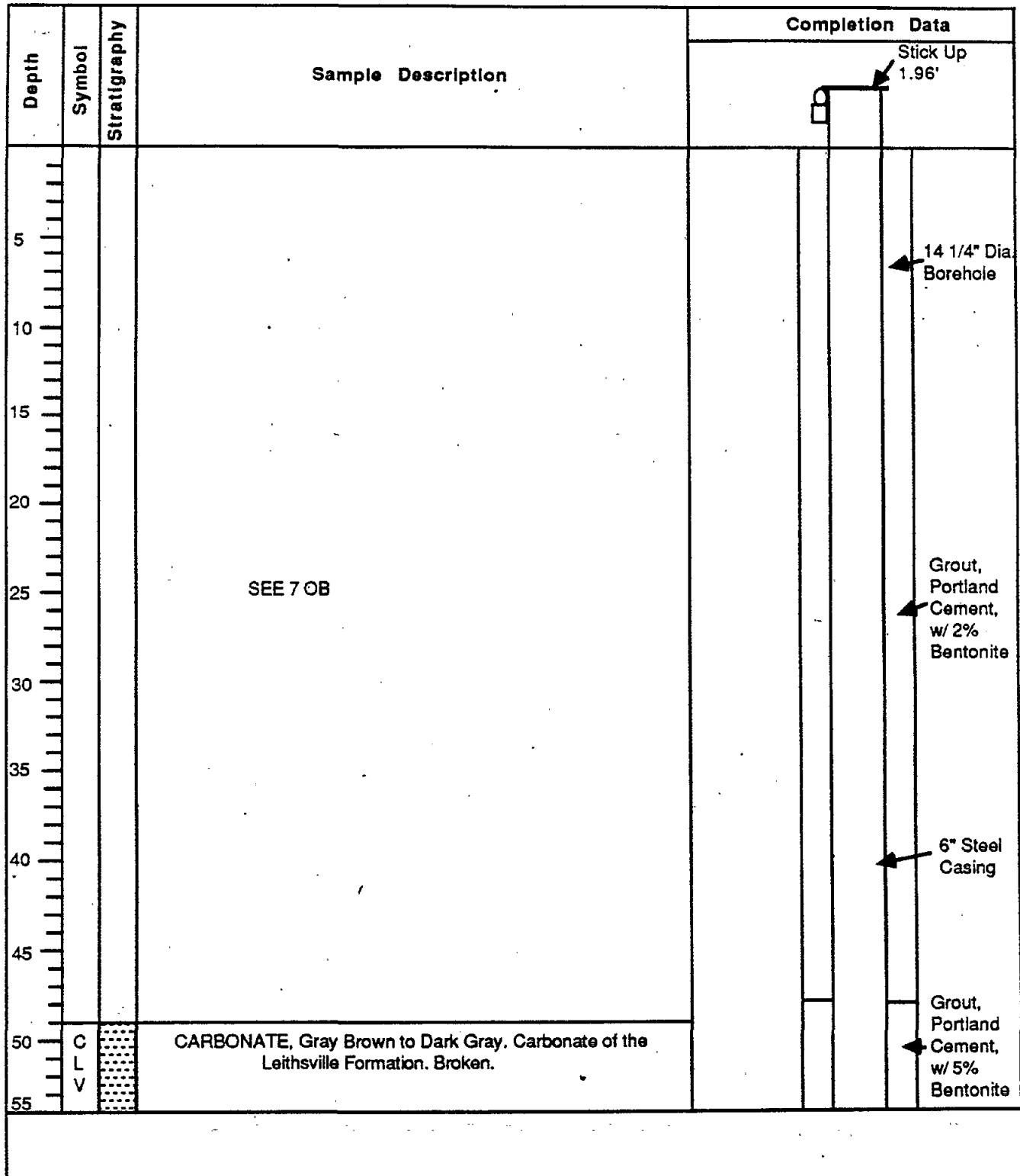
Elevation: Top of Steel Casing: 644.18'

Total Depth: 97.42' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None



AR100097

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 28 March 1988

Well No.: 7R

Site: Hereford Township

Elevation: Top of Steel Casing: 644.18'

Total Depth: 97.42' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data		
60			- Minimal Effervescence with Dilute HCl.			
			- No Productive Fractures.			
85			- Numerous Thin ( < 1 cm ) Calcite, Infilling Fractures.			
70						
75			<u>CARBONATE</u> , Gray to Dark Gray Carbonate.			
80						
85						
90			- Very Broken. Not Productive.			
95			- Productive Clay Seam.			
100			Boring Terminated at 98'.			
105						
110						

AR100098

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 7 April 1988

Well No.: 7DR

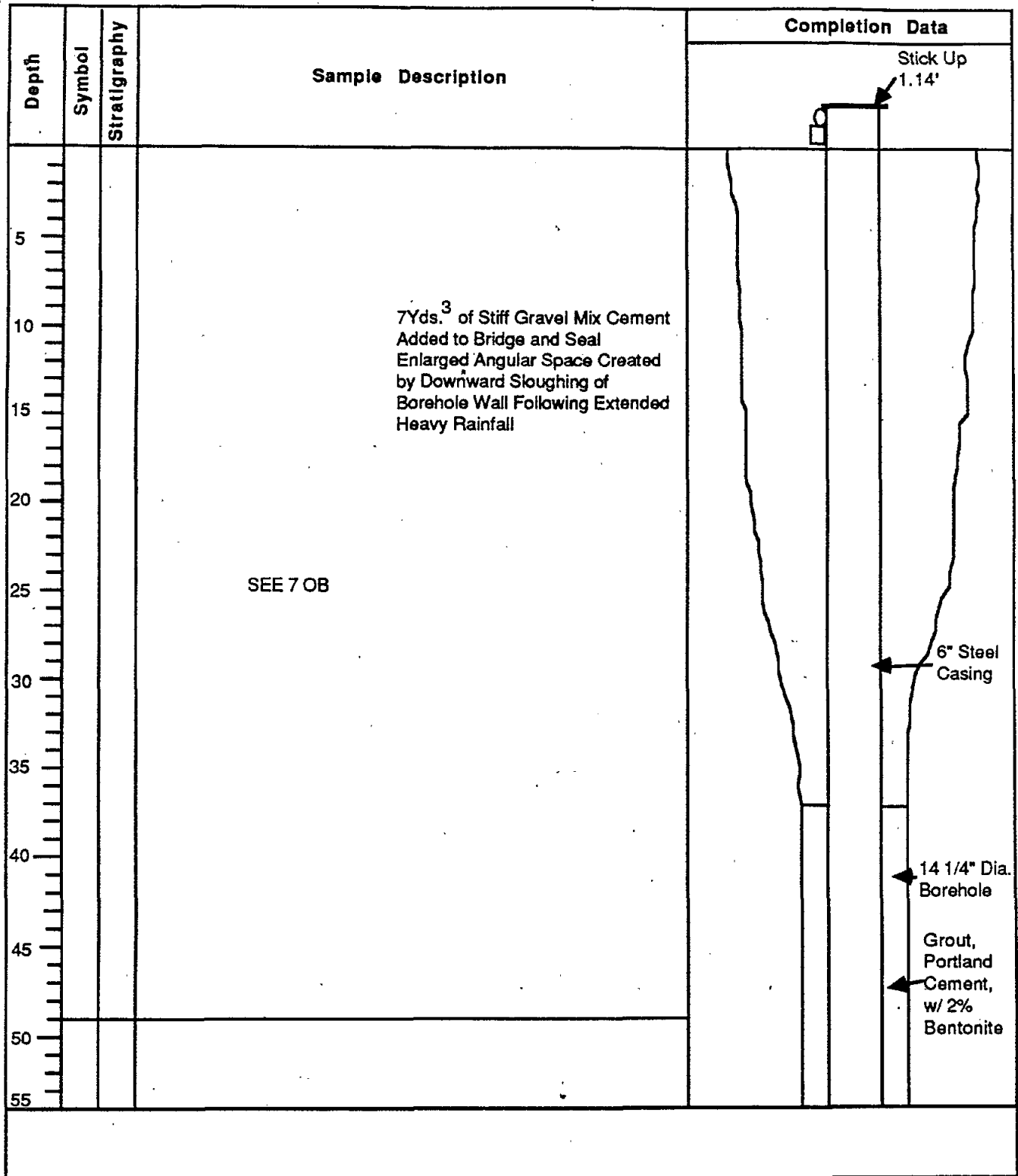
Site: Hereford Township

Elevation: Top of Steel Casing: 643.57'

Total Depth: 124.58' TOC

Casing Size & Type: 6" Welded Steel

Screen Size: None



AR100099

## MONITOR WELL INSTALLATION

Client: EPA-ERT

**Job No.: 1014**

**Date Drilled:** 14-26 April 1988      **Well No.:** 7DR

**Site:** Hereford Township

**Elevation: Top of Steel Casing: 643.57**

**Total Depth:** 124.58' TOC    **Casing Size & Type:** 6" Welded Steel

**Screen Size:** None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data	
60			SEE 7 R		
65					
70					
75					
80					
85					
90					
95					
100			<u>CARBONATE</u> , Dark Gray Carbonate of the Leithsville Formation.		
105	C L V		- Very Broken		
110					

AR100100

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 7 April 1988

Well No.: 7DR

Site: Hereford Township

Elevation: Top of Steel Casing: 643.57

Total Depth: 124.58'

Casing Size & Type: 6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data	
115	C F V		- Broken. No Productive Fractures.		5 5/8" Dia. Open Borehole
120			- Very Broken.		
125			Boring Terminated at 123.4'.		
130					
135					
140					
145					
150					
155					
160					
165					

AR100101

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 1 May 1988

Well No.: 8R

Site: Hereford Township

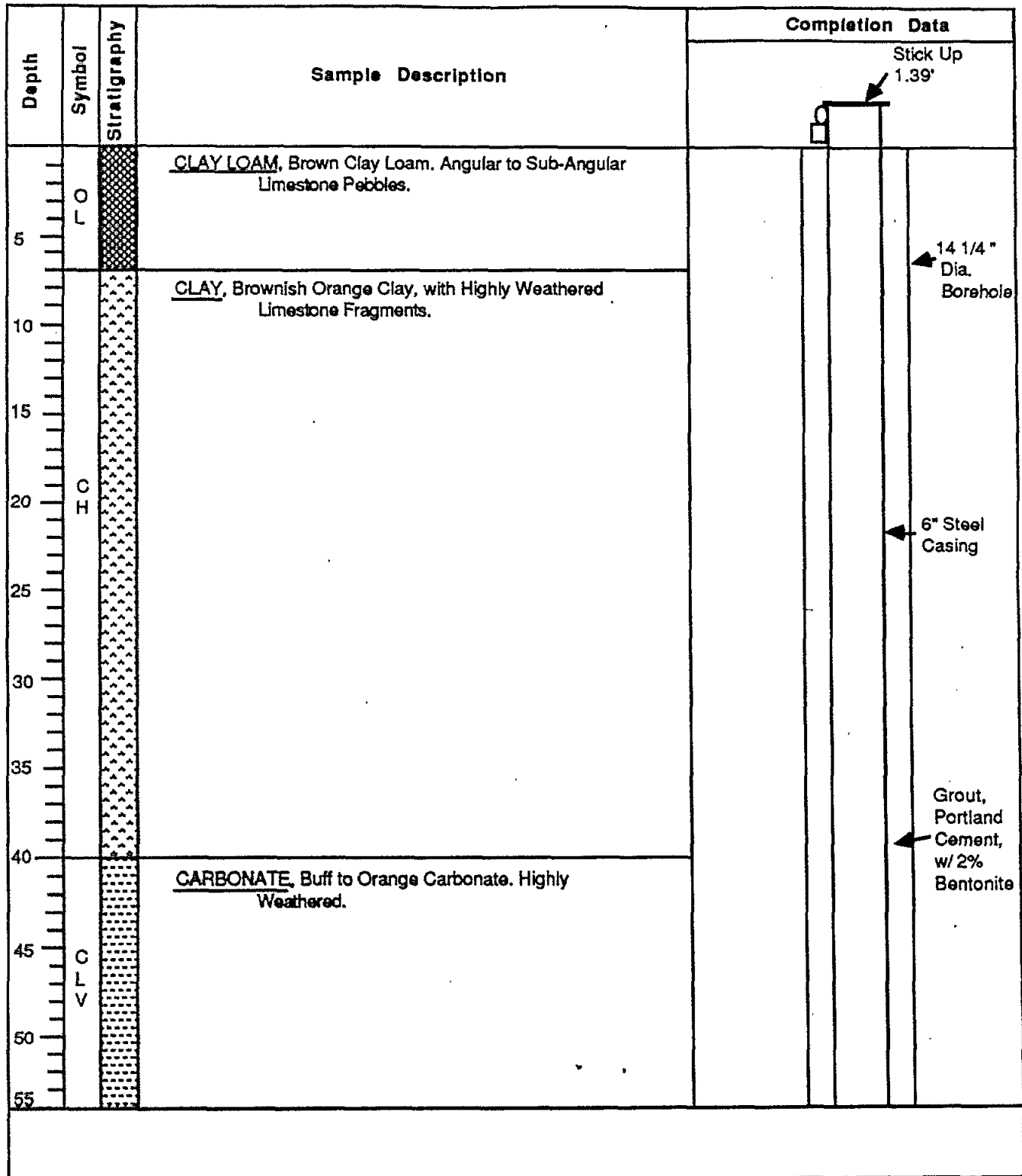
Elevation: Top of Steel Casing: 599.64

Total Depth: 124.71' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None



AR100102

# **MONITOR WELL INSTALLATION**

**Client:** EPA-ERT

**Job No.:** 1014

**Date Drilled:** 1 May 1988

**Well No.:** 8R

**Site:** Hereford Township

**Elevation: Top of Steel Casing:** 599.64

**Total Depth:** 124.71' TOC

**Casing Size & Type:**

6" Welded Steel

**Screen Size:** None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data			
60			- Brown to Gray Dirty LIMESTONE.				
65			- Gray Limestone. Very Hard.				
70							
75							
75	C						
80	L		- Gray Limestone.				
85	V		- Tan to Gray Limestone.				
90							
95							
100			- Fracture. Iron Stained.				
105			- Gray Limestone.				
110							

5 5/8" Dia.  
Open  
Borehole

AR100103

# MONITOR WELL INSTALLATION

Client: EPA-ERT

Job No.: 1014

Date Drilled: 1 May 1988

Well No.: 8R

Site: Hereford Township



Elevation: Top of Steel Casing: 599.64'

Total Depth: 124.71' TOC

Casing Size & Type:

6" Welded Steel

Screen Size: None

Depth	Symbol	Stratigraphy	Sample Description	Completion Data	
115	O L V		- Buff to Gray Limestone.		5 5/8" Dia. Open Borehole
120					
125					
130			Boring Terminated at 124.7'.		
135					
140					
145					
150					
155					
160					
165					

AR100104



APPENDIX B

QA/QC ANALYSIS OF DRILLING WATER AND FLUIDS

AR100105

Analytical Report

HEREFORD TOWNSHIP  
BERKS COUNTY, PENNSYLVANIA

May 6, 1988

EPA Work Assignment Number: 0-14  
Weston Work Order: 3347-01-01-1014  
EPA Contract Number: 68-03-3482

Submitted to:

M. Mortensen  
EPA-ERT

*Michael T. Mulvaney* for S. Posten  
S. Posten  
Task Leader

*5/6/88*  
Date

Analysis by:  
K. Paolino

*James Chang*  
James Chang  
Sampling and Analysis Section Chief

*5/6/88*  
Date

Prepared by:  
K. Paolino

*A. Lo Surdo*  
Antonio Lo Surdo  
S and A QA/QC Officer

*5/6/88*  
Date

Reviewed by:  
A. Lo Surdo

AR100106

## TABLE OF CONTENTS

### Section I

Introduction

Analytical Procedure

Results

Results of Water Analysis for VOA.....Table 1

Results of Oil Analysis for VOA.....Table 2

Results of Oil Fingerprint Analysis.....Table 3

### Section II

QA/QC Procedures

QA/QC Results

Surrogate Standard Recovery Results.....Table 4

Matrix Spike Duplicate Results.....Table 5

EMSL Performance Evaluation Standard Results.....Table 6

### Section III

Volatile Organic Analysis

Calibration Curves

Sample Chromatograms

### Section IV

Oil Fingerprint Raw Data

### Section V

Chain of Custody Records

AR100107

## INTRODUCTION

On April 7, 1988, four (4) water samples and three (3) oil samples were received from the Hereford Township Site in Berks County, Pennsylvania. The analyses requested were volatile organics and oil fingerprinting. The analyses were performed by Weston-REAC personnel.

AR100108

## ANALYTICAL PROCEDURES

### Volatile organic analysis

#### Instrument Parameters

The water and samples were analyzed by purge and trap-GC-FID using EPA Methods 601 and 602 of the Federal Register as guidelines. The following is a list of the test parameters:

Methylene Chloride	Trichloroethene
1,1-Dichloroethane	Benzene
1,1-Dichloroethene	Dibromochloromethane
Trans-1,2-Dichloroethene	1,1,2-Trichloroethane
Chloroform	Cis-1,3-Dichloropropene
1,2-Dichloroethane	Bromoform
1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane
Carbon Tetrachloride	Tetrachloroethene
1,2-Dichloropropane	Chlorobenzene
Bromodichloromethane	Toluene
Trans-1,3-Dichloropropene	Ethyl Benzene

Dibromochloromethane, 1,1,2-trichloroethane, and cis-1,3-dichloropropene are coeluting compounds, thus positive identification and quantification of these compounds are not possible. Tetrachloroethene, and 1,1,2,2-tetrachloroethane are also coeluting compounds. Since 1,1,2,2-tetrachloroethane is rarely encountered in environmental samples, all peaks within this retention time window have been identified and quantified as tetrachloroethene. The percentage of tetrachloroethene was 90% of the mixture.

A Tekmar Purge and Trap concentrator equipped with an automatic liquid sampler and interfaced with a Hewlett-Packard 5840 Gas Chromatograph, ID no. 167823, was used for this analysis. The instrument conditions were set as follows:

Oven Temp 1:	60 °C
Time 1:	3.0 min.
Rate:	8.0 °C/min.
Oven Temp 2:	210 °C
Time 2:	15.0 min.
Injection Temp:	210 °C
FID Temp:	275 °C
Chart Speed:	1.0 cm/min.
Zero:	10.0%
Slope Sens.:	0.07
Helium Flow:	30 mL/min.
Column:	6'x 2mm glass packed with 60/80 mesh Carbopak B coated with 1% SP-1000

AR100109

## Calibration Parameters

Stock solutions of Bromochloromethane (BCM) and VOA's standard mixture were prepared in methanol, respectively, from Supelco BCM standards, and Supelco Purgeable A and B standard mixtures. A 5-point calibration, ranging from 5-100 ug/L, was prepared by serial dilution of the stock solutions in 10 mL of nitrogen purged organic free water and analyzed. The analytical results were least squares fit by linear regression and all analytes in the calibration curve were found to be linear. The daily calibration standards were compared to the 5-point calibration curve and were within acceptable calibration QC limits.

The unknown peak at the retention time of 15.74 min. appearing in the chromatograms has been attributed to the presence of hexane.

The water samples were analyzed as received but the oil samples were diluted. Oil samples, #1493, #1494, and #1495, were diluted one (1) gram of sampled in 100 mls of methanol. Five microliters of the 100x dilution was analyzed in 10 mls of water and no significant peaks were found. The samples were then analyzed at a 1:10 dilution using 5 microliters of the 10x dilution in 10 mls of water. The sample concentrations were calculated using the 5 point calibration curve and the following formula:

$$\text{Sample conc.} = AC - K / M$$

AC = Area Count

K = Constant (intercept)

M = Slope (X-axis coefficient)

The analytical results for the water samples are listed in Table 1 with concentrations reported in ug/L. The analytical results for the oil samples are listed in Table 2 with concentrations reported in ug/g.

AR100110

Table 1. Water Sample Results for Volatile Organics

(concentrations reported in ug/L)

PARAMETER	1491 Left tank	1492 Right tank	1496 Elemen- tary	1497 Elemen- tary
Methylene chloride	10U	10U	10U	10U
1,1-Dichloroethene	5U	5U	5U	5U
1,1-Dichloroethane	5U	5U	5U	5U
trans-1,2-Dichloroethene	5U	5U	5U	5U
Chloroform	10U	10U	10U	10U
1,2-Dichloroethane	5U	5U	5U	5U
1,1,1-Trichloroethane	5U	5U	5U	5U
Carbon tetrachloride	10U	10U	10U	10U
Bromodichloromethane	10U	10U	10U	10U
1,2-Dichloropropane	5U	5U	5U	5U
trans-1,3-Dichloropropene	5U	5U	5U	5U
Trichloroethene	5U	5U	5U	5U
Benzene	5U	5U	5U	5U
Dibromochloromethane*	5U	5U	5U	5U
1,1,2-Trichloroethane*	5U	5U	5U	5U
cis-1,3-Dichloropropene*	5U	5U	5U	5U
Bromoform	10U	10U	10U	10U
1,1,2,2-Tetrachloroethane*	5U	5U	5U	5U
Tetrachloroethene*	5U	5U	5U	5U
Toluene	5U	5U	5U	5U
Chlorobenzene	5U	5U	5U	5U
Ethyl benzene	5U	5U	5U	5U

\*,\* denote coeluting compounds

AR100111

Table 2. Oil Sample Results for Volatile Organics  
(concentrations reported in ug/g)

PARAMETER	1493 Hydraulics Oil	1494 Compressor Oil	1495 Hydraulics Oil
Methylene chloride	200U	200U	200U
1,1-Dichloroethene	100U	100U	100U
1,1-Dichloroethane	100U	100U	100U
trans-1,2-Dichloroethene	100U	100U	100U
Chloroform	200U	200U	200U
1,2-Dichloroethane	100U	100U	100U
1,1,1-Trichloroethane	100U	100U	100U
Carbon Tetrachloride	200U	100U	100U
Bromodichloromethane	200U	200U	200U
1,2-Dichloropropane	100U	100U	100U
trans-1,3-Dichloropropene	100U	100U	100U
Trichloroethene	100U	100U	100U
Benzene	100U	100U	100U
Dibromochloromethane*			
1,1,2-Trichloroethane*	100U	100U	100U
cis-1,3-Dichloropropene*			
Bromoform	340J	200U	200U
1,1,2,2-Tetrachloroethane*			
Tetrachloroethene*	100U	100U	100U
Toluene	290	100U	100U
Chlorobenzene	100U	100U	100U
Ethyl benzene	100U	100U	100U

\*,\* denote coeluting compounds

AR100112



TABLE 3--RESULTS OF HEREFORD OIL FINGERPRINT ANALYSIS

SAMPLE #	PURE PRODUCT	PURE PRODUCT
	1494	1495
#1	no match (nd)	no match (nd)
#2	no match (nd)	no match (nd)

nd denotes not detected. Samples did not contain any oil fingerprint nor peaks. Both water samples were compared to the pure products provided.

AR100113

## QA/QC PROCEDURES

### Volatile Organic Analysis

The surrogate standard recoveries for bromochloromethane are listed in Table 4. The recoveries range from 90 to 110%.

The results of the matrix spike and matrix spike duplicates for sample 1491 are listed in Tables 5. The percent recoveries range from 80% to 128%.

An EPA performance evaluation standard was analyzed. The results of the analyses are listed in Table 6. The percent recoveries range from 99% to 114%.

AR100114

Table 4. Percent recovery of the  
BROMOCHLOROMETHANE

DATE	SAMPLE	%Recovery
4-14-88	5PPB A+B	100
	10PPB A+B	95
	25PPB A+B	99
	50PPB A+B	98
	100PPB A+B	101
	200PPB A+B	110
	EMSL 483 CONC. #4	101
4-15-88	25PPB A+B	104
	1491	90
	1491+25PPB A+B (MS)	100
	1491+25PPB A+B (MSD)	107
	1492	101
	1496	103
	1497	99
	1493 (100x)	97
	1494 (100x)	94
	1495 (100x)	96
4-18-88	25PPB A+B	102
	1493 (10x)	100
	1494 (10x)	103
	1495 (10x)	105
4-19-88	25PPB A+B	103
	EMSL CONC. #4	101
4-20-88	25PPB A+B	101
	EMSL CONC. #4	100
4-21-88	25PPB A+B	102
	25PPB A only	101

AR100115

Table 5. Matrix Spike/Matrix Spike Duplicate  
(concentrations reported as ug/L)

Sample no. 1491

Parameter	Sample conc.	Spike added	Recovered conc MS	MSD	% Recovery MS	MSD	RPD
Methylene Chloride	ND	25	22	24	88	96	8.7
1,1-Dichloroethene	ND	25	22	22	88	88	0.0
1,1-Dichloroethane	ND	25	22	23	88	92	4.4
Trans-1,2-Dichloroethene	ND	25	22	23	88	92	4.4
Chloroform	ND	25	23	23	92	92	0.0
1,2-Dichloroethane	ND	25	22	24	88	96	8.7
1,1,1-Trichloroethane	ND	25	22	23	88	92	4.4
Carbon Tetrachloride	ND	25	22	23	88	92	4.4
Bromodichloromethane	ND	25	24	26	96	104	8.0
1,2-Dichloropropane	ND	25	22	23	88	92	4.4
Trans-1,3-Dichloropropene	ND	25	20	26	80	104	26.1
Trichloroethene	ND	25	22	24	88	96	8.7
Benzene	ND	25	22	23	88	92	4.4
Dibromochloromethane*							
1,1,2-Trichloroethane*	ND	25	20	27	80	108	29.8
Cis-1,3-Dichloropropene*							
Bromoform	ND	25	30	32	120	128	6.5
1,1,2,2-Tetrachloroethane*							
Tetrachloroethene*	ND	25	22	23	88	92	4.4
Toluene	ND	25	23	24	92	96	4.3
Chlorobenzene	ND	25	22	23	88	92	4.4
Ethyl Benzene	ND	25	22	23	88	92	4.4

\*,\* denote coeluting compounds

AR100116

Table 8. EHSI Performance Evaluation  
Standard Results  
(Concentrations reported in ug/L)

Parameter	True Value	Recovered Value	%Recovery
Chloroform	292	305	105
1,2-Dichloroethane	63	66	105
1,1,1-Trichloroethane	38.5	42	109
Carbon tetrachloride	70	72	103
Bromodichloromethane	51.5	75	111
Bromoform	74	67	91
1,1,2,2-Tetrachloroethylene	47.5	54	114

AR100117

APPENDIX C  
RESIDENTIAL WELL DATA SUMMARY

AR100118

## RESIDENTIAL WELL DATA SUMMARY

WELL ID #	NAME					JUNE 1, 1988		JULY 7, 1988		MAY 9-10, 1988	
		EASTING (ft) [a]	NORTHING (ft) [a]	WELL DEPTH (ft)	TOP OF CASING ELEV. (ft)	DEPTH TO WATER (ft)	WATER LEVEL (msl)	DEPTH TO WATER (ft)	WATER LEVEL (msl)	TCE (ppb)	log(10) TCE
R-1	Audolph	62081	26416	7	665 [b]	1.12	663.88	1.24	663.76	ND	0
R-2	Bechtel [deep]	63531	27338	104	906.45	1.41	905.04	19.89	886.56	ND	0
R-2A	Bechtel [shallow]	64611	27455	NS	903.18	NS	NS	NS	NS	ND	0
R-3	Beckner	62938	28045	37	904.74	11.48	893.26	21.14	883.60	ND	0
R-4	Beffield	60854	29259	79	790.81	13.50	777.31	17.46	773.35	NS	NS
R-5	Berry	59184	26035	135	662.92	34.26	628.66	38.19	624.73	347	2.54
R-6	Brown	61266	18534	99	NS	12.17	NS	13.05	NS	ND	0
R-7	Brungard	61512	28752	NS	NS	NS	NS	NS	NS	ND	0
R-8	Camp Mensch Mill: [caretaker]	58107	27966	202	778.91	15.58	763.33	18.60	760.31	ND	0
R-8A	Camp Mensch Mill: [camp]	58323	27335	NS	NS	NS	NS	NS	NS	ND	0
R-9	Cass	59779	25687	77	730.26	34.91	695.35	42.00	686.24	NS	NS
R-10	Clemmer	60350	23831	67	NS	NS	NS	NS	NS	24	1.38
R-11	Crum	60251	24057	58	657.94	6.50	651.44	21.55	636.39	ND	0
R-12	Dabbern	61283	21126	NS	NS	NS	NS	NS	NS	318	2.50
R-13	Dewert	61358	23026	79	624.07	NS	NS	NS	NS	ND [c]	0
R-14	Donovan	61031	19237	123	NS	15.72	NS	19.88	NS	ND	0
R-15	Eberhart	60518	29464	71	767.04	13.00	754.04	15.19	751.85	NS	NS
R-16	Eckert	61441	20207	52	645 [b]	16.28	628.72	25.62	619.38	ND	0
R-17	Finegan	61045	24521	90	720 [b]	10.80	709.20	16.84	703.16	1280	3.11
R-18	Fleming	60682	22911	72	602.55	9.56	592.99	12.39	590.16	343 [c]	2.54
R-19	Fronheiser	58776	26016	NS	NS	NS	NS	NS	NS	ND	0
R-20	Geisinger #2	57335	21407	220	745.36	35.55	709.81	38.65	706.71	ND	0
R-21	Grater	58194	25737	36	697.49	8.00	689.49	11.54	685.95	ND	0
R-22	Hauman	56984	23791	NS	NS	NS	NS	NS	NS	ND	0
R-23	Hill	61460	23038	85	619.63	NS	NS	NS	NS	ND	0
R-24	Hoffmeister	60347	27415	153	880 [b]	32.20	847.80	40.78	839.22	ND	0
R-25	Johnson	59248	25814	172	669.23	44.45	624.78	48.89	620.34	586	2.77
R-26	Karolesky	60900	23390	300	635.02	41.59	593.43	45.97	589.05	ND	0
R-27	Keams [barn]	61197	29028	20	818.05	14.21	803.84	17.00	801.05	ND	0
R-27A	Keams [residence]	61295	28949	NS	NS	NS	NS	NS	NS	ND	0
R-28	Kuhns	61164	18877	NS	NS	NS	NS	NS	NS	24	1.38
R-29	Meitzler, J.	59321	25675	175	668.87	45.10	623.77	49.60	619.27	839	2.92
R-30	Meitzler, K.	59483	25442	257	685.99	53.85	632.14	59.28	626.71	7221	3.86
R-31	Miller, G.	59759	26485	NS	732.37	NS	NS	NS	NS	771	2.89
R-32	Miller, L.	60041	27402	NS	NS	NS	NS	NS	NS	ND	0
R-33	Moser	60668	29434	108	774.67	11.55	763.12	13.85	760.82	NS	NS
R-34	Moyer	60184	24411	125	689.07	36.90	652.17	48.22	640.85	1830	3.26
R-35	Sanzo	60213	22945	59	NS	NS	NS	NS	NS	316	2.50
R-36	Sobjack	61768	24434	125	699.70	44.40	655.30	49.11	650.59	26	1.41
R-37	Stephens	60311	28083	NS	NS	NS	NS	NS	NS	ND	0
R-38	Suavely	62535	23713	85	NS	NS	NS	NS	NS	ND	0
R-39	Wagner [residence]	58382	23929	NS	NS	NS	NS	NS	NS	1890	3.28
R-40	Wagner [tenant]	58461	24126	NS	NS	NS	NS	NS	NS	1414	3.15
R-41	Wetzel, D.	59542	25873	285	692.45	52.20	640.25	53.82	638.63	9425	3.97
R-42	Wetzel	60784	29373	102	783.35	5.88	777.47	9.93	773.62	NS	NS
R-43	Woodland Mobile Home #1	59736	26777	201	744.14	62.30	681.84	63.35	680.79	91 [c]	1.96

ND=Not detected; NS=Not sampled or surveyed

[a] Pennsylvania State coordinate system.

[b] Elevation estimated from mapped surface contours.

[c] Samples collected by Region III TAT during the following periods: R-13:1/19/88; R-18:12/87; R-43:11/9-10/87

AR100119

APPENDIX D  
SLUG TEST DATA

AR100120



## SLUG TEST DATA ANALYSIS

Hvorslev (point piezometer) Method

(Hvorslev, 1951; Freeze and Cherry, 1979)

$$K = \{r^2 (\ln[L/R])\} / (2LT.)$$

for  $L/R > 8$

Where:

K = hydraulic conductivity [ft/sec]

r = casing radius [ft]

L = length of open screen (or borehole) [ft]

R = filter pack (borehole) radius [ft]

T. = 'Basic Time Lag' [sec]

= value of t on semi-logarithmic plot of  $H-h/H-H_0$  vs. t, where  $H-h/H-H_0 = 0.37$

H = initial water level prior to removal of slug

H<sub>0</sub> = water level at t = 0

h = recorded water levels at t > 0

AR100121

MW-1-OB		MW-1.1-OB		MW-1.2-OB		MW-2-R	
t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho
1	0.98	1	0.99	1	0.98	0.5	0.88
10	0.96	10	0.96	2	0.96	1.0	0.65
20	0.94	15	0.92	5	0.94	1.5	0.51
50	0.90	20	0.90	10	0.91	2.0	0.43
150	0.90	25	0.88	15	0.88	2.5	0.40
1097	0.90	30	0.86	20	0.86	3.0	0.37
1507	0.88	35	0.84	25	0.84	3.5	0.31
2007	0.83	40	0.83	30	0.81	4.0	0.29
2377	0.81	45	0.82	56	0.75	4.5	0.25
		50	0.80	76	0.72	5.0	0.23
		60	0.78	106	0.67	5.5	0.21
		82	0.75	156	0.64	6.0	0.19
		92	0.73	206	0.62	6.5	0.17
		102	0.69	256	0.61	7.0	0.16
		132	0.65	306	0.58	7.5	0.15
		162	0.60	356	0.56	8.5	0.13
		202	0.55	406	0.55		
		252	0.47	456	0.53		
		302	0.43	506	0.51		
		352	0.39	556	0.50		
		402	0.35	606	0.49		
		452	0.31	656	0.47		
		502	0.28	706	0.46		
		552	0.25	756	0.44		
		602	0.23	856	0.42		
		652	0.20	956	0.40		
		702	0.19	1056	0.39		
		752	0.17	1156	0.38		
		802	0.15	1206	0.37		
		852	0.15	1256	0.35		
		902	0.13	1356	0.34		
		952	0.12	1406	0.33		
		1002	0.11	1506	0.32		
				1556	0.32		
				1606	0.30		
				1756	0.29		
				1806	0.28		
				1956	0.26		
				2156	0.25		
				2356	0.24		
				2406	0.23		
				2606	0.21		
				2856	0.20		
				2906	0.19		
				3106	0.18		

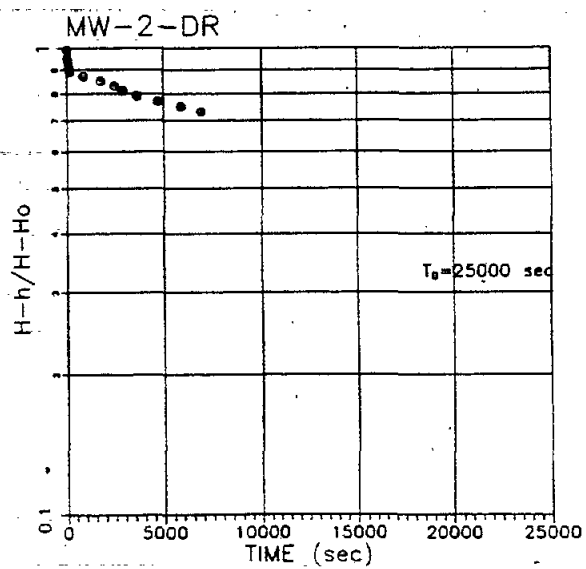
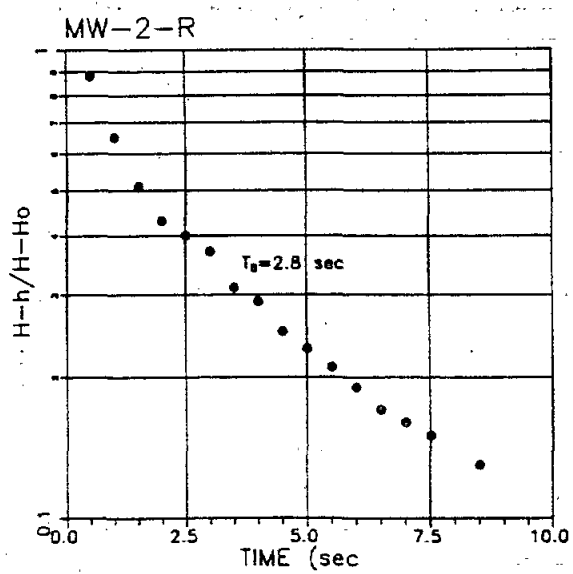
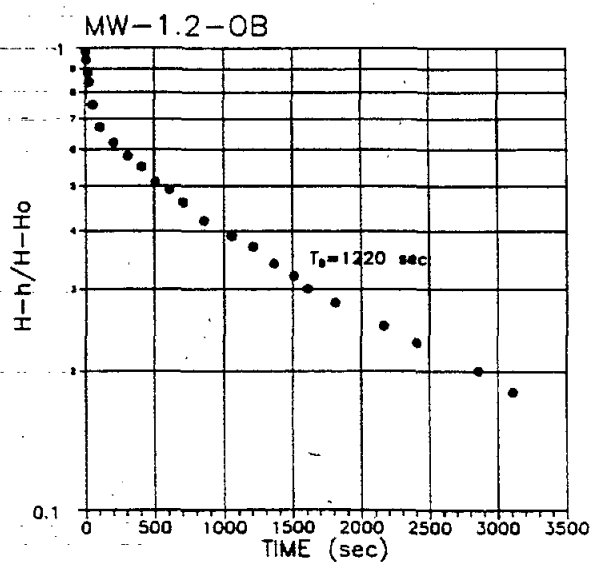
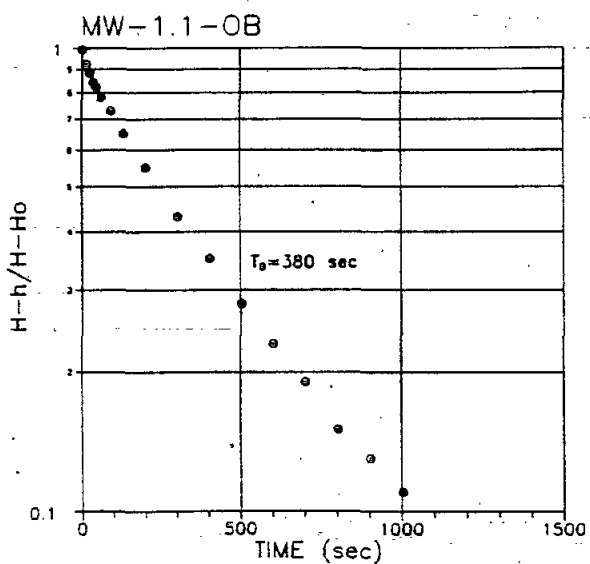
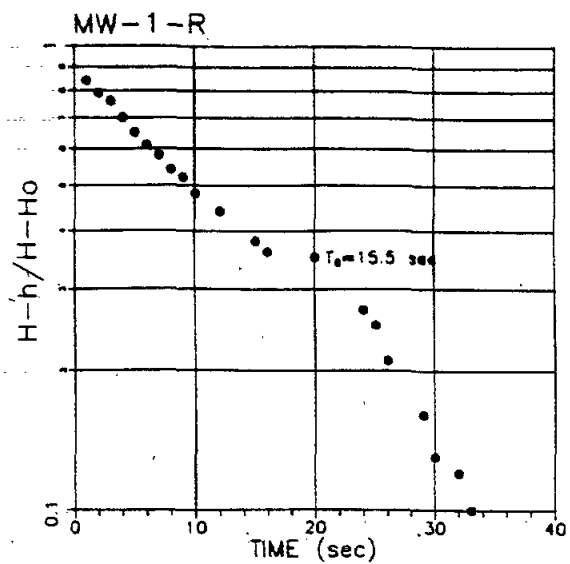
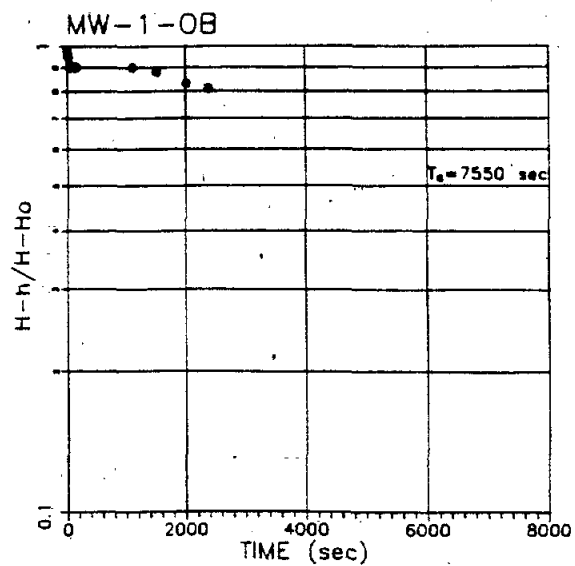
  

MW-1-R		MW-2.1-OB	
t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho
1	0.84	1	0.99
2	0.79	5	0.95
3	0.76	13	0.92
4	0.70	25	0.86
5	0.65	35	0.82
6	0.61	88	0.78
7	0.58	108	0.72
8	0.54	138	0.67
9	0.52	168	0.63
10	0.48	188	0.60
12	0.44	228	0.58
15	0.38	248	0.54
16	0.36	288	0.49
20	0.35	328	0.45
24	0.27	378	0.41
25	0.25	398	0.38
26	0.21	478	0.34
29	0.16	558	0.30
30	0.13	658	0.25
32	0.12	828	0.20
33	0.10	1018	0.15
		1498	0.10

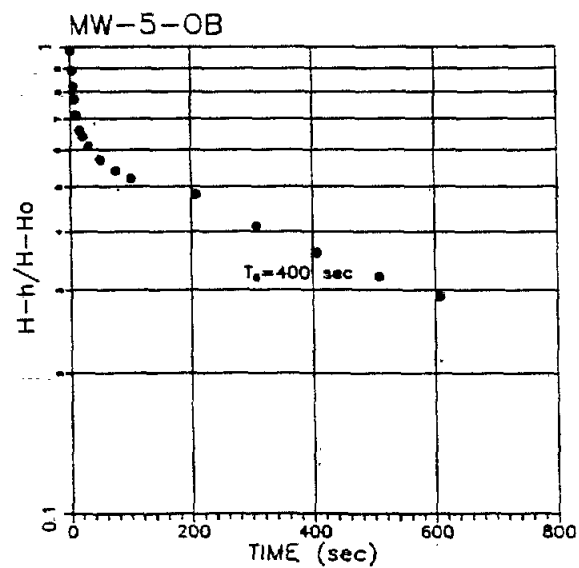
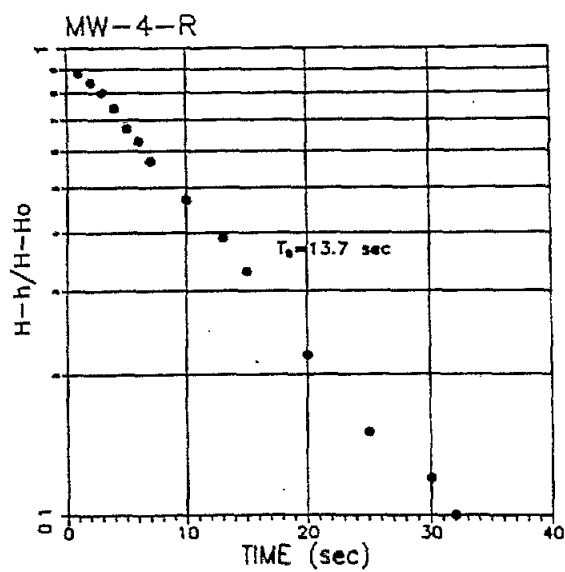
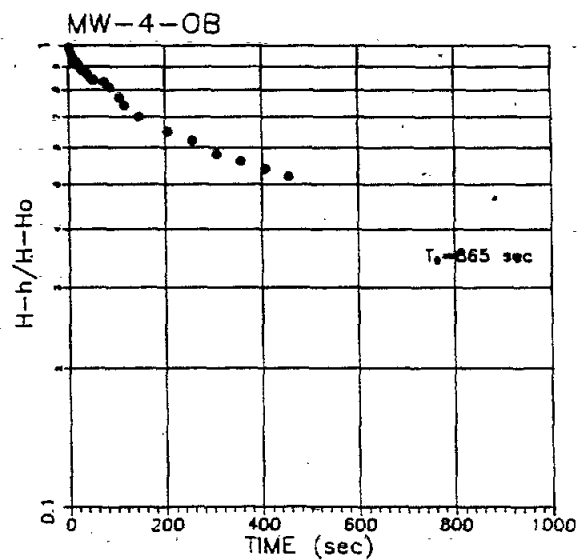
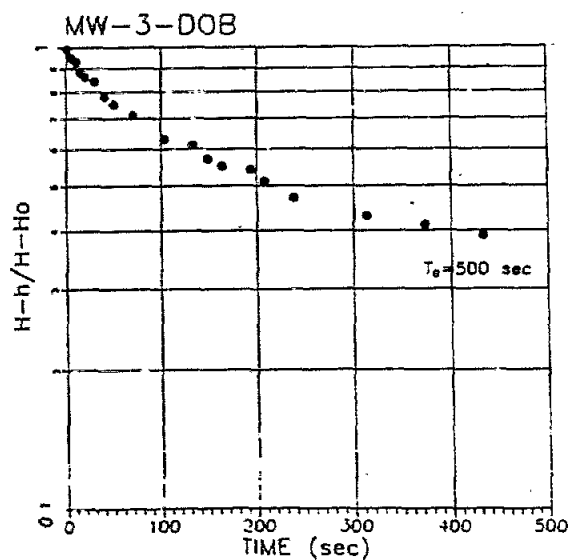
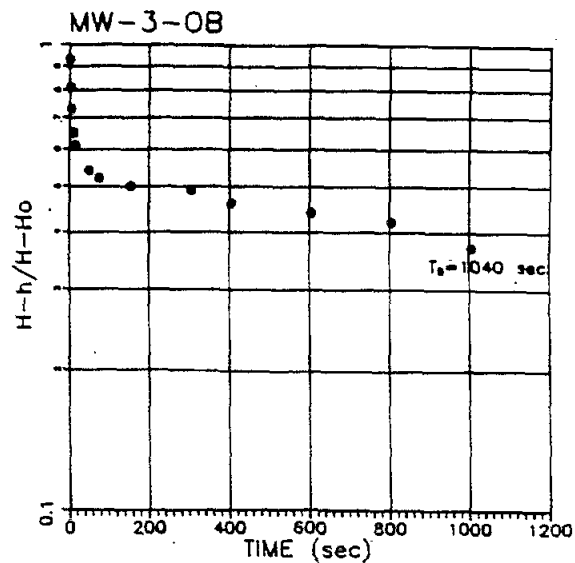
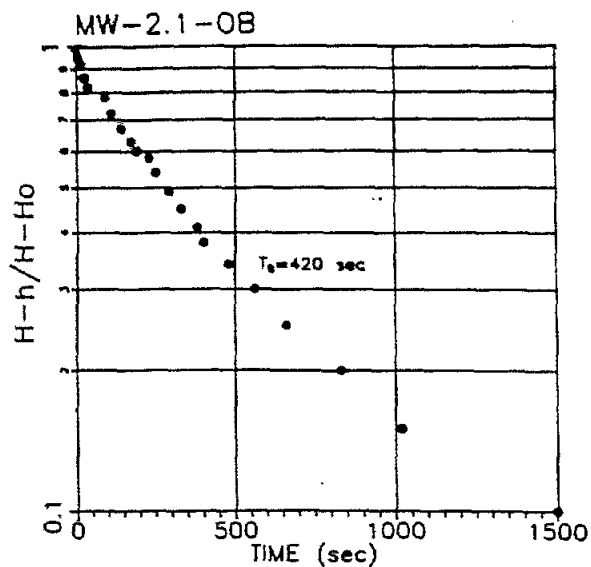
AR100122

MW-2-DR		MW-3-DOB		MW-4-R		MW-5-DOB	
t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho
1	0.99	1	0.99	1	0.88	1	0.96
10	0.97	5	0.95	2	0.84	5	0.95
20	0.95	10	0.93	3	0.80	10	0.93
49	0.94	15	0.88	4	0.74	20	0.88
59	0.93	20	0.86	5	0.67	30	0.84
69	0.92	30	0.84	6	0.63	40	0.78
79	0.91	40	0.78	7	0.57	50	0.73
109	0.90	50	0.75	10	0.47	75	0.71
159	0.89	70	0.71	13	0.39	100	0.68
539	0.88	103	0.63	15	0.33	155	0.63
859	0.87	133	0.61	20	0.22	305	0.61
1539	0.86	148	0.57	25	0.15	505	0.59
1739	0.85	163	0.55	30	0.12	755	0.55
2199	0.84	193	0.54	32	0.10	1005	0.50
2459	0.83	208	0.51			1505	0.42
2719	0.82	238	0.47			1945	0.36
2899	0.81	313	0.43				
3499	0.80	373	0.41				
3619	0.79	433	0.39				
3999	0.78						
4679	0.77						
4979	0.76						
5859	0.75						
6039	0.74						
6879	0.73						
7299	0.72						
MW-3-OB		MW-4-OB		MW-5-OB		MW-5-R	
t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho	t (sec)	H-h/H-Ho
1	0.93	1	0.99	1	0.98	1	0.81
3	0.81	5	0.96	3	0.89	3	0.78
5	0.73	11	0.93	5	0.82	5	0.81
10	0.65	15	0.92	7	0.77	10	0.80
15	0.61	20	0.91	10	0.71	20	0.78
50	0.54	26	0.89	15	0.66	30	0.77
75	0.52	30	0.88	20	0.64	50	0.75
153	0.50	39	0.87	30	0.61	70	0.73
303	0.49	45	0.85	50	0.57	118	0.70
403	0.46	50	0.84	75	0.54	158	0.68
603	0.44	51	0.84	100	0.52	208	0.65
803	0.42	52	0.84	207	0.48	258	0.63
1003	0.37	53	0.84	307	0.41	308	0.60
		75	0.83	407	0.36	358	0.57
		85	0.81	507	0.32	408	0.54
		105	0.77	607	0.29	458	0.52
		115	0.74			508	0.49
		145	0.70			658	0.43
		205	0.65			748	0.40
		255	0.62			808	0.37
		305	0.58			958	0.32
		355	0.56			1018	0.30
		405	0.54			1168	0.25
		455	0.52			1378	0.20
						1618	0.16

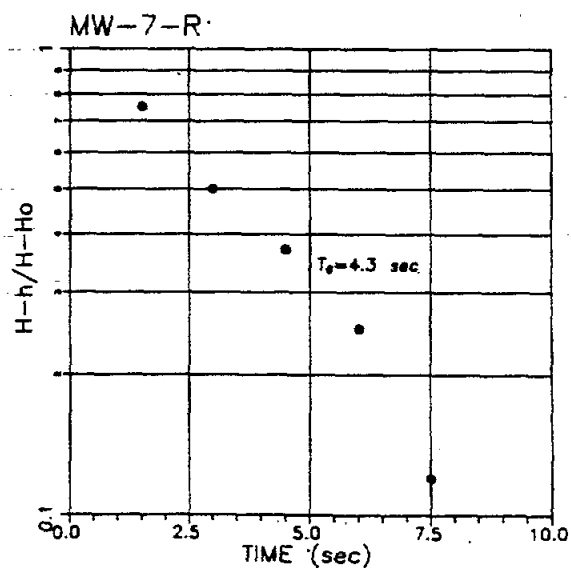
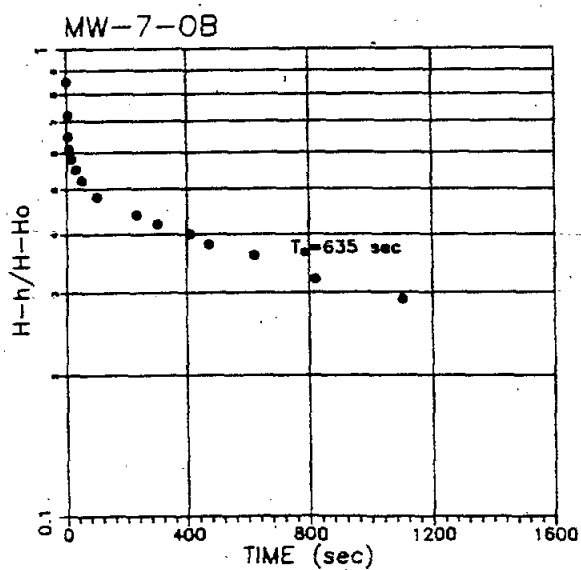
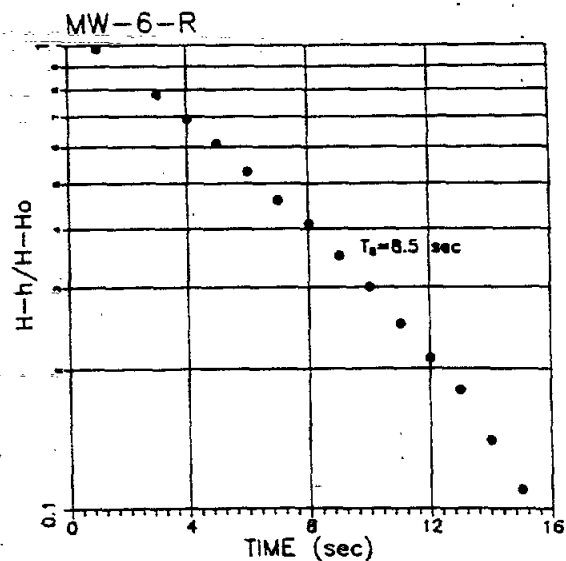
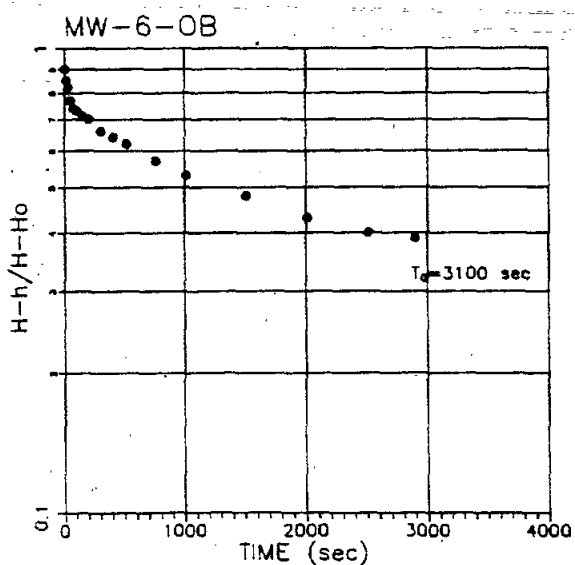
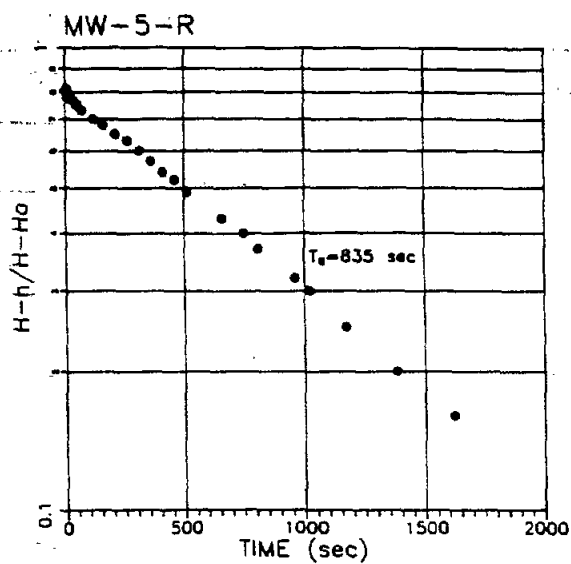
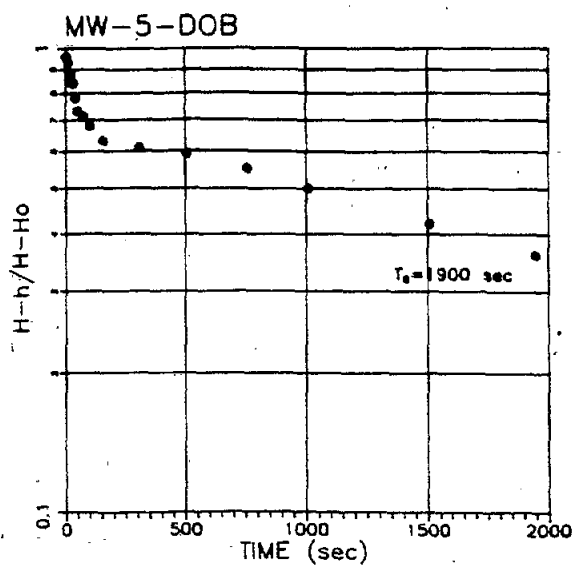
AR100124



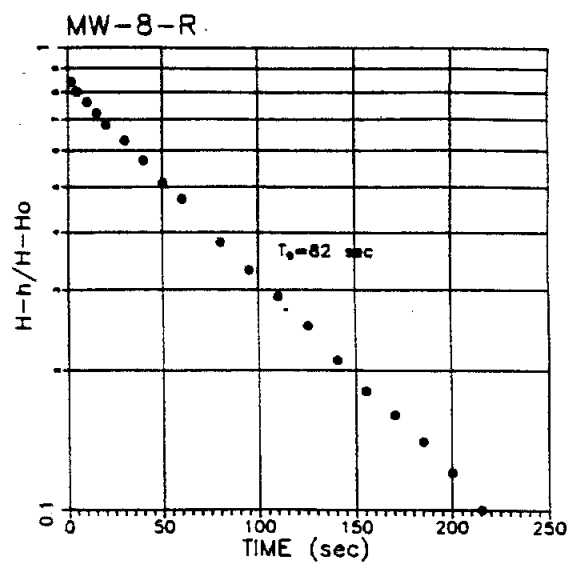
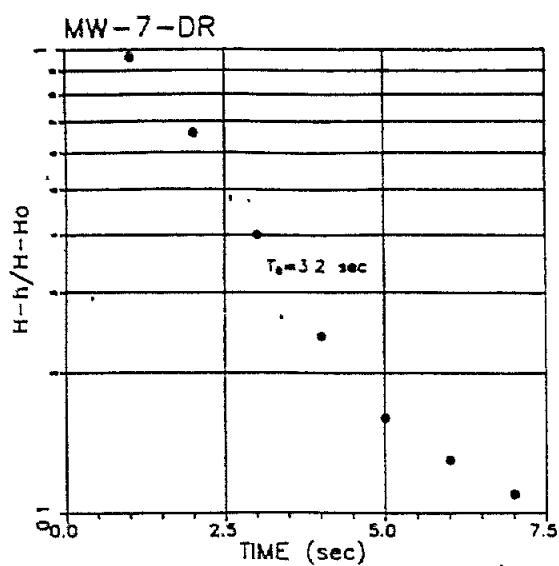
AR100125



AR100126



AR100127



AR100128



APPENDIX E  
PUMP TEST DATA

AR100129

PUMPING WELL: MW-4-R  
PUMP ON: 05/24/88 17:15  
PUMP OFF: 05/26/88 17:17  
PUMP RATE: 50 gpm

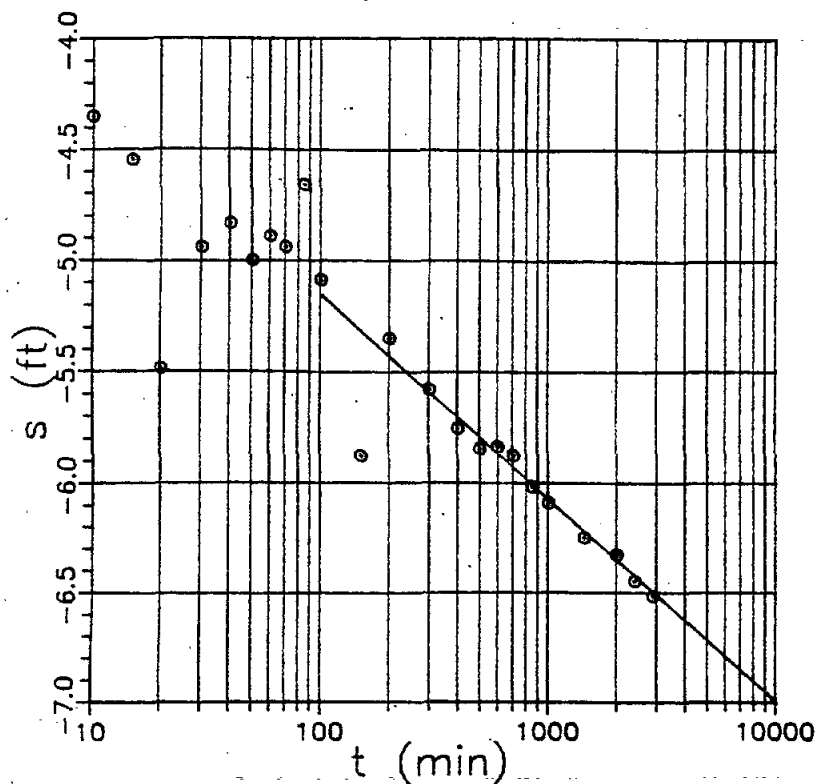
PUMPING WELL: MW-4-R

DRAWDOWN DATA				RECOVERY DATA					
t (min)	DEPTH (ft)	s (ft)	s [a] (ft)	t (min)	t' (min)	t/t'	DEPTH (ft)	s' (ft)	s' [a] (ft)
0	93.57	--	--	2883	1	2883.0	90.98	2.59	2.59
1	86.44	7.13	7.13	2884	2	1442.0	91.39	2.18	2.18
2	86.20	7.37	7.37	2885	3	961.7	91.57	2.00	2.00
3	87.33	6.24	6.24	2886	4	721.5	91.68	1.89	1.89
4	88.91	4.66	4.66	2887	5	577.4	91.75	1.82	1.82
5	89.15	4.42	4.42	2888	6	481.3	91.80	1.77	1.77
6	89.00	4.57	4.57	2889	7	412.7	91.85	1.72	1.72
7	88.99	4.58	4.58	2890.5	8.5	340.1	91.91	1.66	1.66
8.5	89.36	4.21	4.21	2892	10	289.2	91.95	1.62	1.62
10	89.22	4.35	4.35	2897	15	193.1	92.09	1.48	1.48
15	89.02	4.55	4.55	2902	20	145.1	92.18	1.39	1.39
20	88.08	5.49	5.49	2912	30	97.1	92.30	1.27	1.27
30	88.63	4.94	4.94	2922	40	73.1	92.41	1.16	1.15
40	88.73	4.84	4.83	2932	50	58.6	92.48	1.09	1.08
50	88.56	5.01	5.00	2942	60	49.0	92.56	1.01	1.00
60	88.67	4.90	4.89	2952	70	42.2	92.60	0.97	0.96
70	88.62	4.95	4.94	2967	85	34.9	92.69	0.88	0.87
85	88.90	4.67	4.66	2982	100	29.8	92.75	0.82	0.81
100	88.47	5.10	5.09	3032	150	20.2	92.91	0.66	0.64
150	87.67	5.90	5.88	3082	200	15.4	93.02	0.55	0.52
200	88.19	5.38	5.35	3182	300	10.6	93.13	0.44	0.40
300	87.95	5.62	5.58	3282	400	8.2	93.22	0.35	0.30
400	87.76	5.81	5.76	3382	500	6.8	93.27	0.30	0.24
500	87.66	5.91	5.85	3482	600	5.8	93.31	0.26	0.18
600	87.65	5.92	5.84	3582	700	5.1	93.33	0.24	0.15
700	87.60	5.97	5.88						
850	87.44	6.13	6.02						
1000	87.35	6.22	6.09						
1440	87.14	6.43	6.25						
2000	86.99	6.58	6.33						
2400	86.82	6.75	6.45						
2880	86.68	6.89	6.52						

[a] Drawdown/recovery data corrected for observed groundwater recession curve (rate of regional groundwater discharge) =  $1.27 \times 10^{-4}$  ft/min.

AR100130

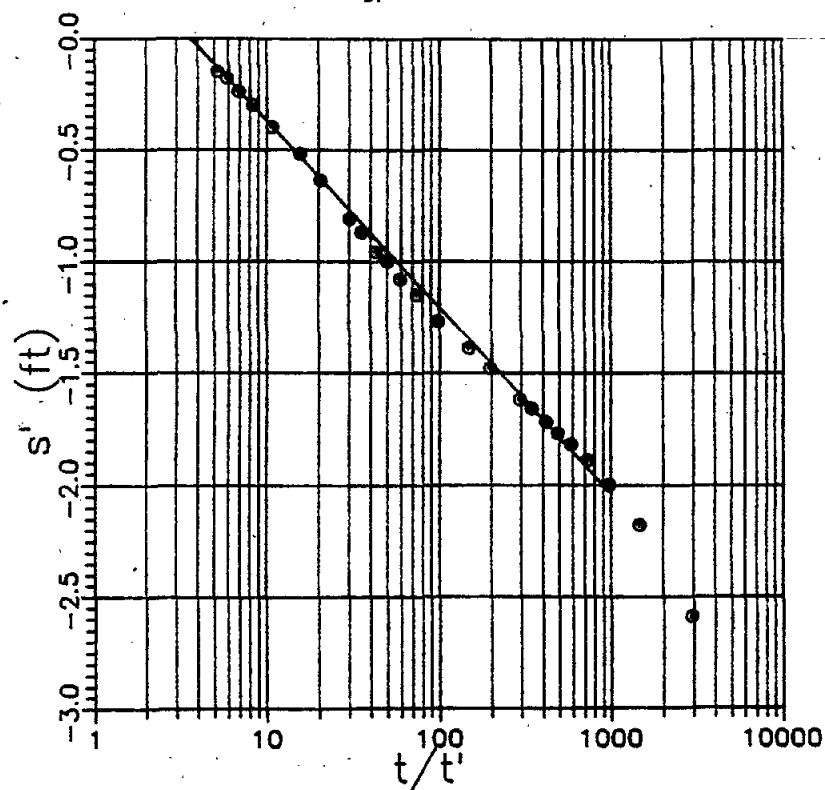
PUMPING WELL DRAWDOWN PLOT  
 PUMPING WELL: MW-4-R  
 PUMPING RATE: 50 gpm



$$\begin{aligned} T &= 264Q/s \\ &= 264(50)/(6.05-5.15) \\ &= 14667 \text{ gpd/ft} \end{aligned}$$

$$\begin{aligned} K &= T/b \\ &= 14667/11 \\ &= 1333 \text{ gpd/ft} \end{aligned}$$

PUMPING WELL RECOVERY PLOT  
 PUMPING WELL: MW-4-R  
 PUMPING RATE: 50 gpm



$$\begin{aligned} T &= 264Q/s' \\ &= 264(50)/(1.20-0.35) \\ &= 15529 \text{ gpd/ft} \end{aligned}$$

$$\begin{aligned} K &= T/b \\ &= 15529/11 \\ &= 1412 \text{ gpd/ft} \end{aligned}$$

AR100131

PUMPING WELL: MW-4-R  
PUMP ON: 05/24/88 17:15  
PUMP OFF: 05/26/88 17:17  
PUMP RATE: 50 gpm

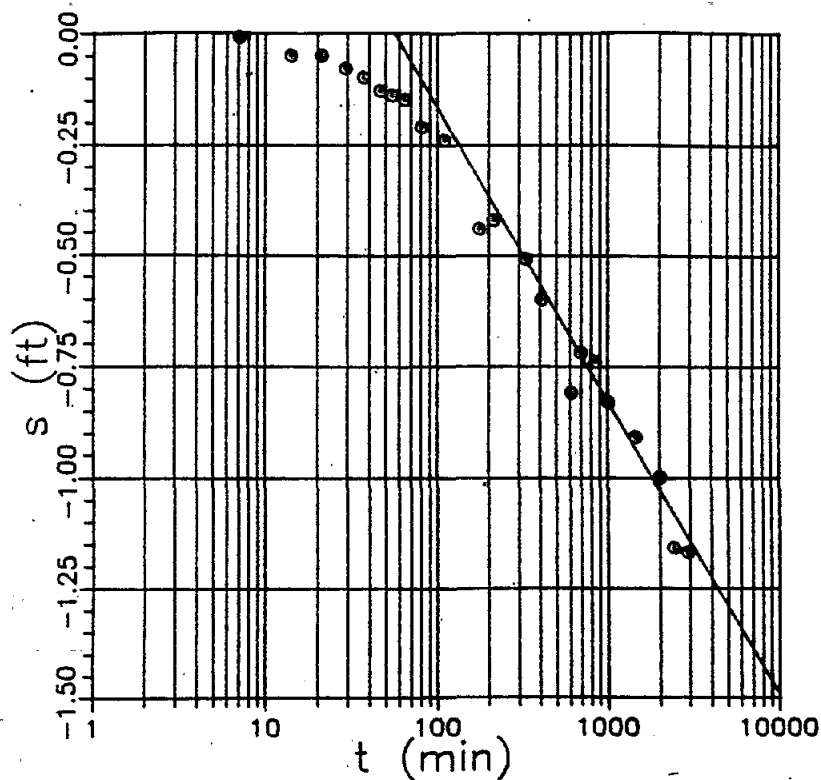
OBSERVATION WELL: BERRY

DRAWDOWN DATA				RECOVERY DATA					
t (min)	DEPTH (ft)	s (ft)	s [a] (ft)	t (min)	t' (min)	t/t'	DEPTH (ft)	s' (ft)	s' [a] (ft)
0	33.75	--	--	2883	1	2883.0	35.29	1.54	1.54
7	33.76	0.01	0.01	2887	5	577.4	35.23	1.48	1.48
14	33.80	0.05	0.05	2888	6	481.3	35.23	1.48	1.48
21	33.80	0.05	0.05	2895.5	13.5	214.5	35.18	1.43	1.43
29	33.83	0.08	0.08	2900	18	161.1	35.14	1.39	1.39
37	33.85	0.10	0.10	2912	30	97.1	35.06	1.31	1.31
46	33.89	0.14	0.13	2922	40	73.1	35.06	1.31	1.30
54	33.90	0.15	0.14	2932	50	58.6	35.02	1.27	1.26
64	33.91	0.16	0.15	2942	60	49.0	35.00	1.25	1.24
80	33.97	0.22	0.21	2952	70	42.2	35.00	1.25	1.24
109	34.00	0.25	0.24	2967	85	34.9	34.96	1.21	1.20
174	34.21	0.46	0.44	2982	100	29.8	34.94	1.19	1.18
212	34.20	0.45	0.42	3032	150	20.2	34.82	1.07	1.05
328	34.30	0.55	0.51	3082	200	15.4	34.78	1.03	1.00
405	34.40	0.65	0.60	3138	256	12.3	34.68	0.93	0.90
605	34.64	0.89	0.81	3400	518	6.6	34.50	0.75	0.68
690	34.56	0.81	0.72	3515	633	5.6	34.50	0.75	0.67
839	34.60	0.85	0.74	3746	864	4.3	34.66	0.91	0.80
1000	34.71	0.96	0.83	3917	1035	3.8	34.33	0.58	0.45
1440	34.84	1.09	0.91						
2002	35.00	1.25	1.00						
2400	35.21	1.46	1.16						
2880	35.29	1.54	1.17						

[a] Drawdown/recovery data corrected for observed groundwater recession curve (rate of regional groundwater discharge) =  $1.27 \times 10^{-4}$  ft/min.

AR100132

OBSERVATION WELL DRAWDOWN PLOT  
OBSERVATION WELL: BERRY  
PUMPING WELL: MW-4-R (50 gpm)



$$T = 264Q/s$$

$$= 264(50)/(0.83-0.18)$$

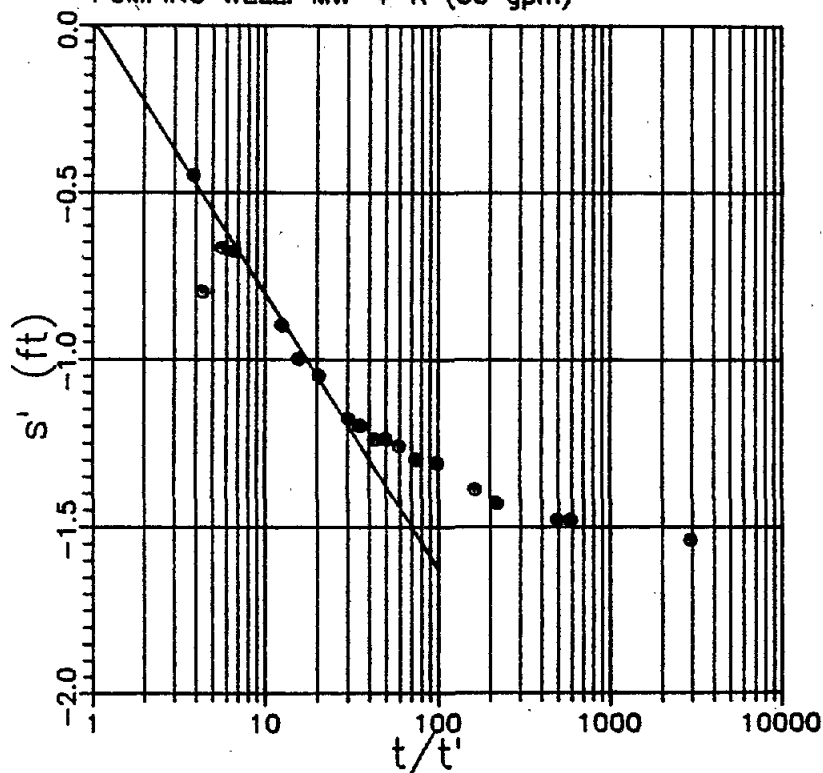
$$= 20368 \text{ gpd/ft}$$

$$S = Tt/4790r^2$$

$$= 22000(55)/4790(460)^2$$

$$= 1.1 \times 10^{-2}$$

OBSERVATION WELL RECOVERY PLOT  
OBSERVATION WELL: BERRY  
PUMPING WELL: MW-4-R (50 gpm)



$$T = 264Q/s'$$

$$= 264(50)/(1.6-0.8)$$

$$= 16500 \text{ gpd/ft}$$

AR100133

PUMPING WELL: MW-4-R  
PUMP ON: 05/24/88 17:15  
PUMP OFF: 05/26/88 17:17  
PUMP RATE: 50 gpm

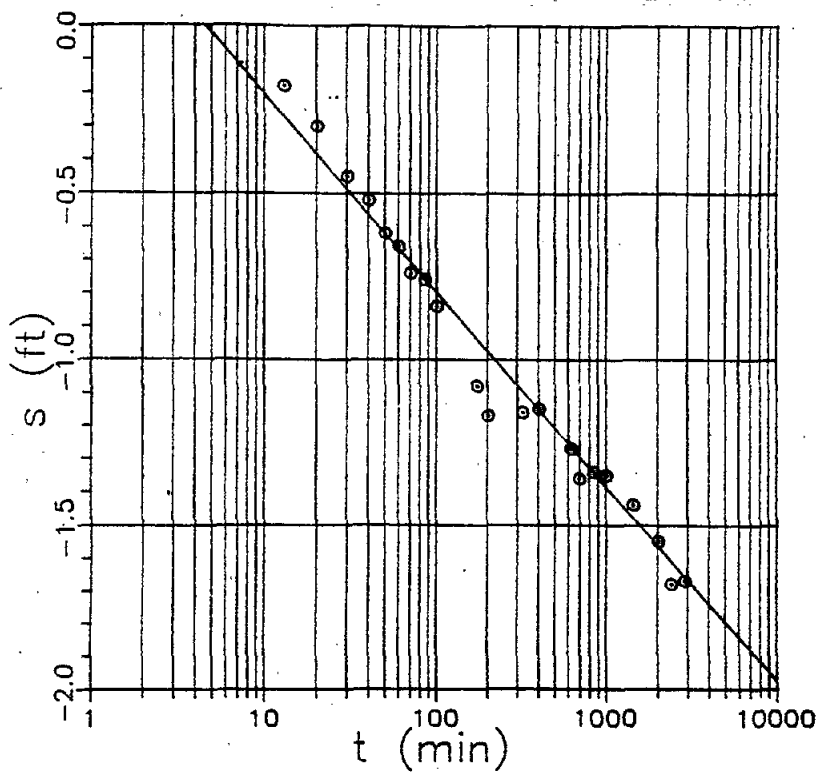
OBSERVATION WELL: JOHNSON

DRAWDOWN DATA				RECOVERY DATA					
t (min)	DEPTH (ft)	s (ft)	s [a] (ft)	t (min)	t' (min)	t/t'	DEPTH (ft)	s' (ft)	s' (ft)
0	43.65	--	--	2885	3	961.7	45.68	2.03	2.03
13	43.83	0.18	0.18	2889	7	412.7	45.50	1.85	1.85
20	43.95	0.30	0.30	2892.5	10.5	275.5	45.36	1.71	1.71
30	44.10	0.45	0.45	2897	15	193.1	45.25	1.60	1.60
40	44.18	0.53	0.52	2902	20	145.1	45.20	1.55	1.55
50	44.28	0.63	0.62	2912	30	97.1	45.02	1.37	1.37
60	44.32	0.67	0.66	2922	40	73.1	44.96	1.31	1.30
70	44.40	0.75	0.74	2932	50	58.6	44.84	1.19	1.18
85	44.42	0.77	0.76	2942	60	49.0	44.76	1.11	1.10
100	44.50	0.85	0.84	2952	70	42.2	44.70	1.05	1.04
173	44.75	1.10	1.08	2967	85	34.9	44.60	0.95	0.94
200	44.85	1.20	1.17	2982	100	29.8	44.54	0.89	0.88
320	44.85	1.20	1.16	3032	150	20.2	44.39	0.74	0.72
400	44.85	1.20	1.15	3082	200	15.4	44.30	0.65	0.62
620	45.00	1.35	1.27	3142	260	12.1	44.16	0.51	0.48
695	45.10	1.45	1.36	3405	523	6.5	44.00	0.35	0.28
843	45.10	1.45	1.34	3518	636	5.5	44.00	0.35	0.27
1000	45.13	1.48	1.35	3743	861	4.3	43.97	0.32	0.21
1440	45.27	1.62	1.44	3915	1033	3.8	43.87	0.22	0.09
2006	45.45	1.80	1.55						
2400	45.63	1.98	1.68						
2880	45.69	2.04	1.67						

[a] Drawdown/recovery data corrected for observed groundwater recession curve (rate of regional groundwater discharge) =  $1.27 \times 10^{-4}$  ft/min.

AR100134

OBSERVATION WELL DRAWDOWN PLOT  
OBSERVATION WELL: JOHNSON  
PUMPING WELL: MW-4-R (50 gpm)



$$T = 264Q/8s$$

$$= 264(50)/(1.38-0.78)$$

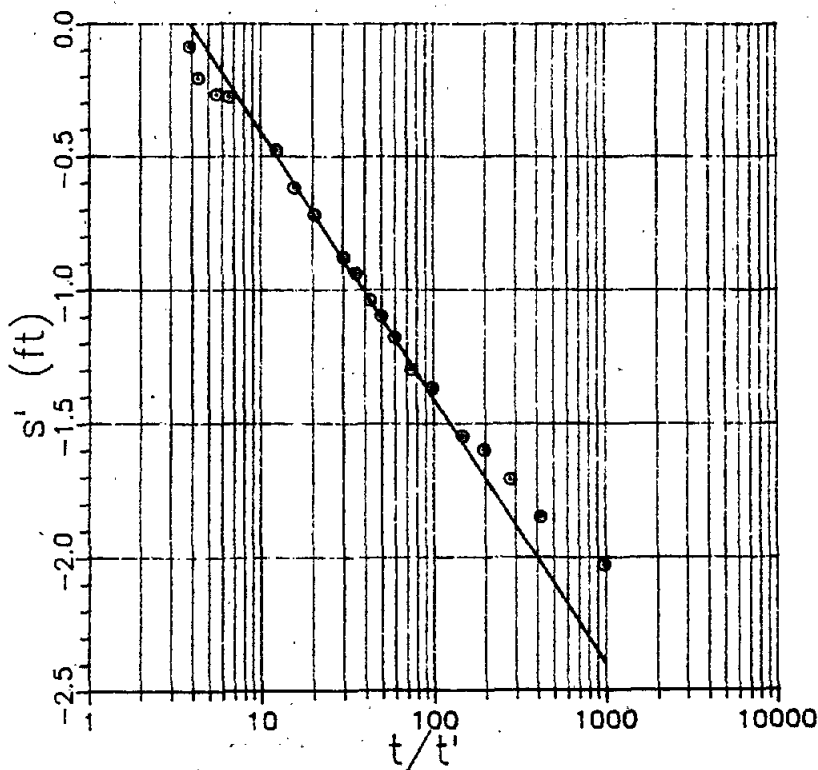
$$= 22000 \text{ gpd/ft}$$

$$S = Tt_s/4790r^2$$

$$= 22000(4.5)/4790(255)^2$$

$$= 3.2 \times 10^{-4}$$

OBSERVATION WELL RECOVERY PLOT  
OBSERVATION WELL: JOHNSON  
PUMPING WELL: MW-4-R (50 gpm)



$$T = 264Q/8s'$$

$$= 264(50)/(1.4-0.4)$$

$$= 13200 \text{ gpd/ft}$$

AR100135

PUMPING WELL: MW-4-R  
PUMP ON: 05/24/88 17:15  
PUMP OFF: 05/26/88 17:17  
PUMP RATE: 50 gpm

OBSERVATION WELL: J. MEITZLER

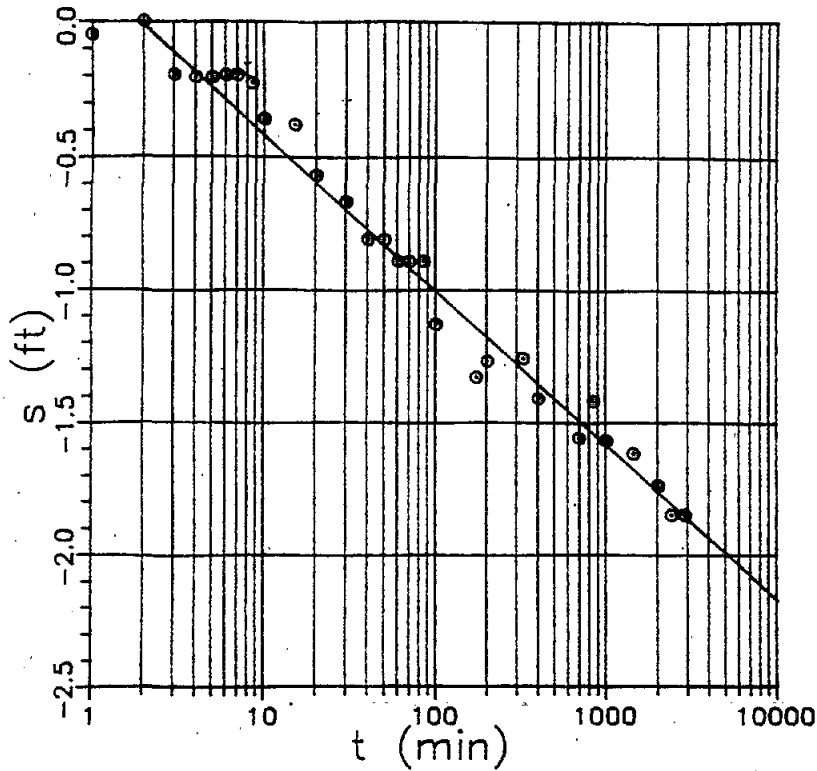
DRAWDOWN DATA				RECOVERY DATA					
t (min)	DEPTH (ft)	s (ft)	s [a] (ft)	t (min)	t' (min)	t/t'	DEPTH (ft)	s' (ft)	s' [a] (ft)
0	44.10	--	--	2883	1	2883.0	46.32	2.22	2.22
1	44.15	0.05	0.05	2888	6	481.3	46.15	2.05	2.05
2	44.10	0.00	0.00	2892	10	289.2	46.00	1.90	1.90
3	44.30	0.20	0.20	2902	20	145.1	45.70	1.60	1.60
4	44.31	0.21	0.21	2907	25	116.3	45.70	1.60	1.60
5	44.31	0.21	0.21	2920	38	76.8	45.57	1.47	1.47
6	44.30	0.20	0.20	2932	50	58.6	45.49	1.39	1.38
7	44.30	0.20	0.20	2941	59	49.8	45.44	1.34	1.33
8.5	44.33	0.23	0.23	2949	67	44.0	45.39	1.29	1.28
10	44.46	0.36	0.36	2968	86	34.5	45.26	1.16	1.15
15	44.48	0.38	0.38	2983	101	29.5	45.26	1.16	1.15
20	44.67	0.57	0.57	3032	150	20.2	45.07	0.97	0.95
30	44.77	0.67	0.67	3083	201	15.3	44.87	0.77	0.74
40	44.92	0.82	0.81	3145	263	12.0	44.82	0.72	0.69
50	44.92	0.82	0.81	3411	529	6.4	44.75	0.65	0.58
60	45.00	0.90	0.89	3524	642	5.5	44.57	0.47	0.39
70	45.00	0.90	0.89	3740	858	4.4	44.56	0.46	0.35
85	45.00	0.90	0.89	3913	1031	3.8	44.50	0.40	0.27
100	45.24	1.14	1.13						
173	45.45	1.35	1.33						
200	45.40	1.30	1.27						
325	45.40	1.30	1.26						
400	45.56	1.46	1.41						
695	45.75	1.65	1.56						
843	45.63	1.53	1.42						
1000	45.80	1.70	1.57						
1440	45.90	1.80	1.62						
2009	46.10	2.00	1.74						
2400	46.25	2.15	1.85						
2880	46.32	2.22	1.85						

[a] Drawdown/recovery data corrected for observed groundwater recession curve (rate of regional groundwater discharge) =  $1.27 \times 10^{-4}$  ft/min.

AR100136



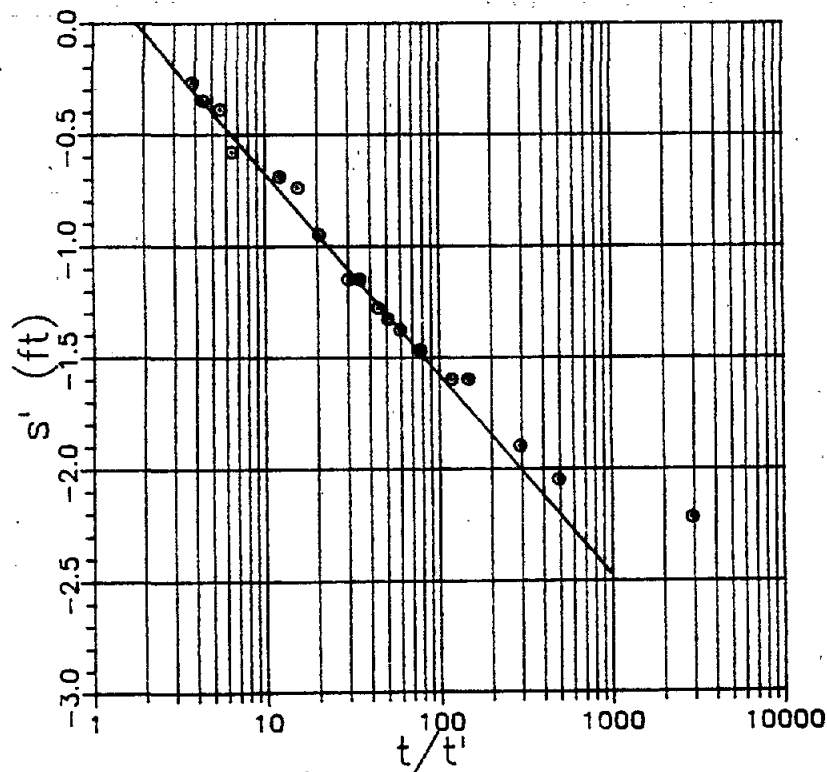
OBSERVATION WELL DRAWDOWN PLOT  
OBSERVATION WELL: J. MEITZLER  
PUMPING WELL: MW-4-R (50 gpm)



$$\begin{aligned} T &= 264Q/\delta s \\ &= 264(50)/(1.55-0.98) \\ &= 23158 \text{ gpd/ft} \end{aligned}$$

$$\begin{aligned} S &= Tt_s/4790r^2 \\ &= 23158(2)/4790(135)^2 \\ &= 5.3 \times 10^{-4} \end{aligned}$$

OBSERVATION WELL RECOVERY PLOT  
OBSERVATION WELL: J. MEITZLER  
PUMPING WELL: MW-4-R (50 gpm)



$$\begin{aligned} T &= 264Q/\delta s' \\ &= 264(50)/(1.59-0.68) \\ &= 14505 \text{ gpd/ft} \end{aligned}$$

AR100137

PUMPING WELL: MW-4-R  
PUMP ON: 05/24/88 17:15  
PUMP OFF: 05/26/88 17:17  
PUMP RATE: 50 gpm

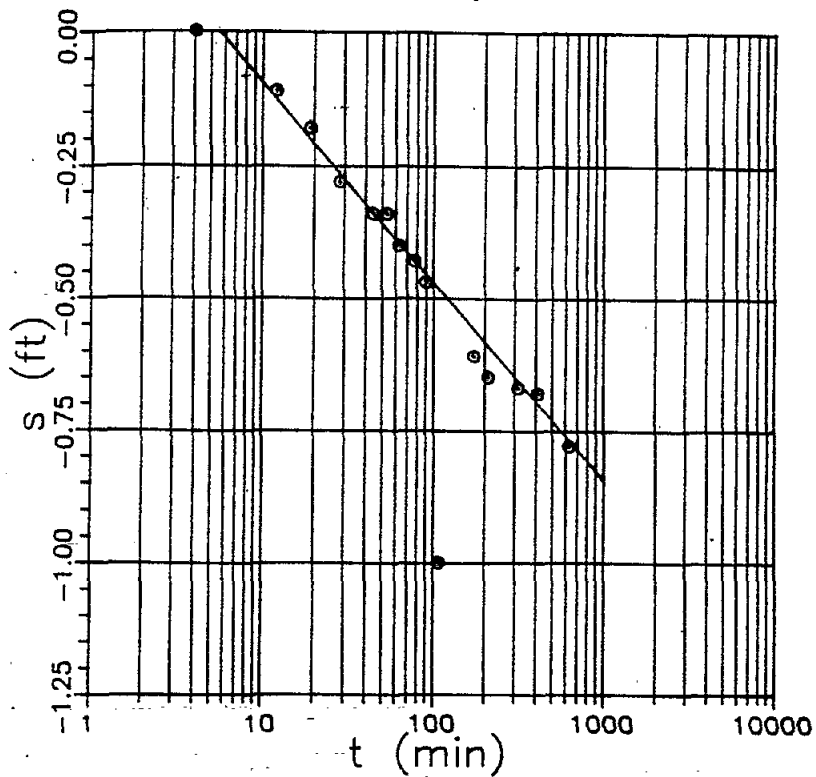
OBSERVATION WELL: K. MEITZLER

DRAWDOWN DATA				RECOVERY DATA					
t (min)	DEPTH (ft)	s (ft)	s [a] (ft)	t (min)	t' (min)	t/t'	DEPTH (ft)	s' (ft)	s' [a] (ft)
0	53.47	--	--	2885	3	961.7	54.50	1.03	1.03
4	53.47	0	0.00	2890	8	361.3	54.32	0.85	0.85
12	53.58	0.11	0.11	2895	13	222.7	54.29	0.82	0.82
19	53.65	0.18	0.18	2904	22	132.0	54.12	0.65	0.65
28	53.75	0.28	0.28	2911	29	100.4	54.12	0.65	0.65
44	53.82	0.35	0.34	2922	40	73.1	54.05	0.58	0.57
53	53.82	0.35	0.34	2934	52	56.4	54.00	0.53	0.52
62	53.88	0.41	0.40	2944	62	47.5	53.95	0.48	0.47
77	53.91	0.44	0.43	2951	69	42.8	53.92	0.45	0.44
90	53.95	0.48	0.47	2970	88	33.8	53.83	0.36	0.35
107	54.48	1.01	1.00	3030	148	20.5	53.74	0.27	0.25
171	54.1	0.63	0.61	3080	198	15.6	53.64	0.17	0.14
208	54.15	0.68	0.65	3136	254	12.3	53.60	0.13	0.10
312	54.18	0.71	0.67	3529	647	5.5	53.33	-0.14	-0.22
408	54.2	0.73	0.68						
620	54.33	0.86	0.78						
715	54.29	0.82	0.73						
854	54.29	0.82	0.71						
1007	54.28	0.81	0.68						
1440	54.32	0.85	0.67						
2016	54.39	0.92	0.66						
2404	54.45	0.98	0.67						
2879	54.50	1.03	0.66						

[a] Drawdown/recovery data corrected for observed groundwater recession curve (rate of regional groundwater discharge) =  $1.27 \times 10^{-4}$  ft/min.

AR100138

OBSERVATION WELL DRAWDOWN PLOT  
OBSERVATION WELL: K. MEITZLER  
PUMPING WELL: MW-4-R (50 gpm)



$$T = 264Q/S_s$$

$$= 264(50)/(0.85-0.47)$$

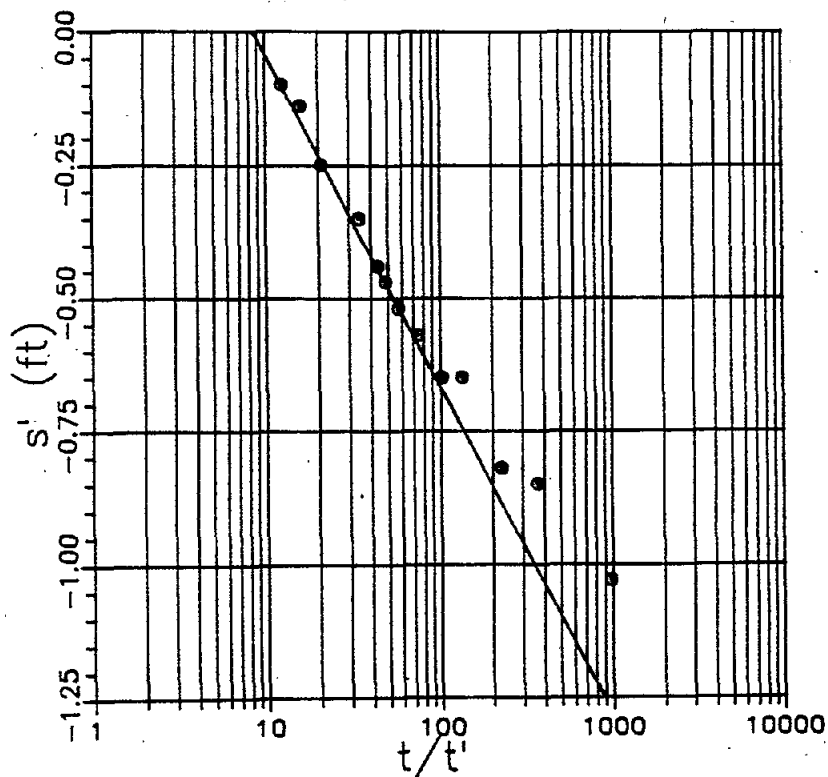
$$= 34737 \text{ gpd/ft}$$

$$S = Tt_s/4790r^2$$

$$= 22000(5.4)/4790(225)$$

$$= 7.7 \times 10^{-4}$$

OBSERVATION WELL RECOVERY PLOT  
OBSERVATION WELL: K. MEITZLER  
PUMPING WELL: MW-4-R (50 gpm)



$$T = 264Q/S_s'$$

$$= 264(50)/(0.66-0.05)$$

$$= 21640 \text{ gpd/ft}$$

AR100139

## DRAWDOWN DATA

MW-4-08			WETZEL	
t (min)	DEPTH (ft)	s (ft)	DEPTH (ft)	s (ft)
0	13.48	--	92.23	--
1	13.48	0.00	92.25	-0.02
2	13.48	0.00	92.25	-0.02
3	13.49	-0.01	92.19	0.04
4	13.51	-0.03	92.24	-0.01
5	13.51	-0.03	92.25	-0.02
6	13.51	-0.03	92.23	0.00
7	13.51	-0.03	92.24	-0.01
8.5	13.52	-0.04	92.24	-0.01
10	13.51	-0.03	92.23	0.00
15	13.48	0.00	92.22	0.01
20	13.45	0.03	92.18	0.05
30	13.39	0.09	92.05	0.18
40	13.42	0.06	92.12	0.11
50	13.43	0.05	92.16	0.07
60	13.47	0.01	92.26	-0.03
70	13.44	0.04	92.29	-0.06
85	13.44	0.04	92.28	-0.05
100	13.37	0.11	92.11	0.12
150	13.44	0.04	91.40	0.83
200	13.48	0.00	91.74	0.49
300	13.57	-0.09	91.79	0.44
400	13.57	-0.09	91.83	0.40
500	13.60	-0.12	91.90	0.33
600	13.61	-0.13	91.94	0.29
700	13.63	-0.15	92.00	0.23
850	13.60	-0.12	92.04	0.19
1000	13.60	-0.12	92.07	0.16
1440	13.54	-0.06	92.08	0.15
2000	13.43	0.05	92.29	-0.06
2400	13.29	0.19	92.29	-0.06
2880	13.39	0.09	92.44	-0.21

## RECOVERY DATA

MW-4-08					WETZEL	
t (min)	t' (min)	t/t'	DEPTH (ft)	s' (ft)	DEPTH (ft)	s' (ft)
2883	1	2883.0	13.41	0.07	92.44	-0.21
2884	2	1442.0	13.47	0.01	92.45	-0.22
2885	3	961.7	13.45	0.03	92.46	-0.23
2886	4	721.5	13.42	0.06	92.47	-0.24
2887	5	577.4	13.41	0.07	92.47	-0.24
2888	6	481.3	13.39	0.09	92.47	-0.24
2889	7	412.7	13.41	0.07	92.47	-0.24
2890.5	8.5	340.1	13.37	0.11	92.46	-0.23
2892	10	289.2	13.37	0.11	92.45	-0.22
2897	15	193.1	13.34	0.14	92.48	-0.25
2902	20	145.1	13.39	0.09	92.49	-0.26
2912	30	97.1	13.38	0.10	92.48	-0.25
2922	40	73.1	13.36	0.12	92.52	-0.29
2932	50	58.6	13.38	0.10	92.59	-0.36
2942	60	49.0	13.39	0.09	92.60	-0.37
2952	70	42.2	13.33	0.15	92.58	-0.35
2967	85	34.9	13.36	0.12	92.59	-0.36
2982	100	29.8	13.39	0.09	92.60	-0.37
3032	150	20.2	13.36	0.12	--	--
3082	200	15.4	13.36	0.12	--	--
3182	300	10.6	13.34	0.14	--	--
3282	400	8.2	13.32	0.16	--	--
3382	500	6.8	13.31	0.17	--	--
3482	600	5.8	13.32	0.16	--	--
3582	700	5.1	13.31	0.17	--	--

AR100140

CASE			WELL R5		
DRAWDOWN DATA			DRAWDOWN DATA		
t (min)	DEPTH (ft)	s (ft)	t (min)	DEPTH (ft)	s (ft)
0	35.75	--	0	36.05	--
1	35.75	0.00	2	36.05	0.00
9	35.72	-0.03	11	36.02	-0.03
16	35.70	-0.05	18	36.02	-0.03
24	35.57	-0.18	26	36.02	-0.03
31	35.93	0.18	34	36.00	-0.05
41	35.16	-0.59	43	36.03	-0.02
49	36.27	0.52	51	36.03	-0.02
57	36.00	0.25	60	36.03	-0.02
73	35.86	0.11	77	36.03	-0.02
84	35.86	0.11	88	36.03	-0.02
104	35.78	0.03	105	36.03	-0.02
145	36.15	0.40	147	36.00	-0.05
200	35.10	-0.65	205	36.01	-0.04
303	35.68	-0.07	309	35.86	-0.19
399	35.61	-0.14	406	35.95	-0.10
613	37.62	1.87	607	36.92	0.87
725	35.46	-0.29	713	35.75	-0.30
865	36.38	0.63	858	35.82	-0.23
1000	35.70	-0.05	1004	35.79	-0.26
1436	35.62	-0.13	1439	35.63	-0.42
2012	35.20	-0.55	2012	35.48	-0.57
2399	35.13	-0.62	2401	35.40	-0.65
2876	35.08	-0.67			

AR100141

APPENDIX F

SOIL GAS SURVEY: MARCH 10-12, 1988

AR100142



REAC SUPPORT ORGANIZATION  
GSA RARITAN DEPOT  
WOODBIDGE AVENUE  
BUILDING 209, 8AY F  
EDISON, NJ 08837  
PHONE: 201-906-0369

DATE: June 22, 1988  
TO: Marty Mortensen, ERT Work Assignment Manager  
FROM: Brian Brass, REAC Task Leader  
SUBJECT: SOIL GAS SURVEY FOR THE HEREFORD TOWNSHIP GROUNDWATER  
CONTAMINATION SITE, BECKS COUNTY, PA

The Hereford Township Groundwater contamination site is located in Eastern Berks County, PA, approximately 60 miles northwest of Philadelphia. In November 1983, the Pennsylvania Department of Environmental Resources (PADER) took tap water samples in response to citizen complaints about water quality. Analytical results indicated elevated (greater than 5 ppb) levels of TCE and PCE in well waters. PADER and the EPA determined that the contaminants posed a threat to public health and an investigation and removal action were initiated.

In December 1987, ERT and REAC began a groundwater investigation that included several shallow overburden and deep rock well. As the well drilling progressed, and additional geologic and hydrological data was gathered, the utility of a soil gas survey was suggested.

In March 1988, ERT, with REAC assistance, performed two soil gas surveys at the Hereford Township Groundwater contamination site. An initial screening soil gas survey was developed and conducted to: 1) test the appropriateness of soil gas methodology for the specific site; 2) locate areas of highest contamination; and, 3) gain additional information concerning the site. A second soil gas survey was conducted to further define contamination and confirm results from the original survey.

Both of the surveys conducted were standard soil gas surveys. A standard soil gas survey begins by defining the area to be investigated. The area selected is usually a location where contamination is suspected. First, a 5 ft by 1/2 in. hole is pounded into the soil with a slambar or slide hammer. A hollow, stainless steel soil gas probe is inserted through this hole into the soil. The soil to probe interface is sealed with bentonite. A portable air sampling pump is then utilized to evacuate the soil gas probe. Next, an HNU is connected to the probe and the soil gas is screened with the HNU. Finally, a Tedlar air bag sample is then collected from the soil gas probe and submitted for gas chromatograph analysis.

eh:rd/BRASS/M-11

AR100143

In conjunction with the standard soil gas survey, an ~~ambient air~~ infiltration test was conducted. This test utilized a hexane-soaked cloth which was placed close to the soil probe interface. The ~~theory behind~~ this method is that if ambient air is infiltrating the soil gas, the hexane will do the same and the hexane contamination will be detected. Two of the three ambient air infiltration tests (I39H, J47H, P81H) indicated significant hexane contamination. Prior to the ambient air infiltration test, a Tedlar bag sample was collected; none of these samples contained hexane while two of the three test bags were contaminated with hexane. Therefore, it is reasonable to conclude that the hexane contamination originated from the hexane-soaked cloth that was placed near the sampling probe. Further investigation into this occurrence is required to determine the infiltration rate and ways of mitigating this problem.

The actual soil gas surveys screened ~~89~~ sampling points in 17 separate transects. The HNU data and Photovac GC data were compared to determine if a correlation existed between a positive deflection of the HNU and the detection of contaminants in the Tedlar air bags with a Photovac GC. For the purpose of this study, a deflection of ~~the HNU~~ greater than or equal to 0.1 HNU units ( $\geq 100$  ppb) was considered a positive HNU hit. This is equivalent to the lowest detection level of the HNU. Similarly, for the Photovac GC, a detection limit of approximately 5 ppb was established. The Photovac has a greater sensitivity and the readings are less subjective than the HNU readings. This immediately biases the correlation between positive HNU readings and positive Photovac results because of the Photovac's greater sensitivity. However, because the HNU has a lower sensitivity than the Photovac, a positive on the HNU should be a positive on the Photovac. Unfortunately, the HNU readings were taken directly from the soil gas probes while the Photovac readings were derived from the Tedlar bag samples. Factors that might result in lower Photovac readings include: ambient air dilution, photo and thermal degradation, diffusion through the Tedlar bags, etc. Of the 89 samples subjected to HNU and Photovac testing, 29 samples did not correlate. This gives approximately 67 percent correlation for the soil gas survey.

In addition to the soil gas survey, 11 well headspaces were screened with the HNU and Photovac. The HNU/Photovac correlation for the well headspaces was 82%. This correlation is significantly better than the soil gas data. Although the soil gas data had a larger reference (89 samples vs. 11 for the headspaces), the poor correlation for the soil gas requires further investigation. This poor correlation may be soil dependent or sampling technique dependent or both.

The Hereford site is not an ideal location for application of the soil gas technique. ~~The soils are extremely rocky and shallow, the geology is fractured, and the terrain diverse.~~ Impermeable rock layers may also effect the soil gas concentrations. Aside from the adverse conditions, the soil gas survey does appear to have provided some useful information. The HNU data indicates heavy contamination in the area of transects (F through J). The Photovac data also confirms contamination in these areas (although at lower concentrations). The contamination in these areas

eh:rd/BRASS/M-11

AR100144



contained quantifiable amounts of TCE and PCE. This area was heavily forested with very rocky soil containing a significant amount of decaying organic matter. The rocky soil may have played a role in causing dilution of the Tedlar bag samples due to the ambient air infiltration previously indicated. Another area that the Photovac indicates contamination in the field by the M transect. However, this contamination is not TCE or PCE -- it is a much heavier compound and may be associated with decaying organic matter. Additional contamination was detected throughout the site mostly at low levels. The Photovac data indicates high levels of contamination by the P and Q transects. This is mostly heavier compounds not TCE or PCE. Sampling point Q84 contains both TCE and PCE. No explanation for the high levels of heavier unknown compounds can be provided except that they may be from isolated surface spills.

The soil gas survey and well headspace results appear to indicate several small spills occurring in different locations over a significant period of time a number of years ago. This hypothesis is based upon the presence of, and concentration ratios of, cis and trans, dichloroethylene to TCE, and the wide dispersion of groundwater contamination. The geology of the area and transport of contaminants within fracture zones as well as impermeable rock layers may have interfered with the soil gas survey. Therefore, only the general conclusions provided may be made at this time.

TABLE 1  
MCKEYFORD TOWNSHIP, Mckeesport, PA  
Photovac GC Screening Results, 10 MAR - 12 MAR 88

Concentrations expressed as ppb														
SAMPLE ID	HMI (ppm)	TOTAL VOLATILES (ppm)	VINYL CHLORIDE											
			(14) (a)	1,1-DCE (28)	BENZENE (80)	TCE (114)	TOLUENE (219)	UNKNOWN (291)	PCE (340)	UNKNOWN (394)	ETHYL BENZENE (525)	META XYLENE (580)	O-XYLENE/STYRENE (705)	UNKNOWN TOLUENE (1146)
TEDLAR BAG AIR SAMPLES COLLECTED FROM WELL HEADSPACE														
MCK08	2	0.67	ND	ND	ND	670	ND	ND	ND	ND	NR	NR	NR	NR
MCK08	MCB	0	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR
MCK08	MCB	0.15	ND	ND	ND	150	ND	ND	ND	ND	NR	NR	52	NR
MCK08	0.5	0.01	ND	ND	ND	10	ND	ND	ND	ND	NR	NR	ND	NR
MCK08	4	4.44	ND	ND	ND	4420	ND	ND	40	ND	NR	NR	ND	NR
MCK08	2.5	0.03	ND	ND	ND	7740	ND	ND	290	ND	NR	NR	NR	NR
MCK08	MCB	0	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR	ND	NR
MCK08	MCB	0.034	3	ND	ND	3	ND	ND	1	ND	NR	NR	NR	NR
MCK08	0.4	0.44	ND	ND	ND	440	ND	ND	ND	ND	NR	NR	NR	NR
MCK08	40	0.167	ND	ND	ND	165	ND	ND	2	ND	NR	NR	ND	NR
MCK08	MCB	0	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR
SOIL GAS SAMPLING POINTS														
A1	MCB	0.023	16	ND	1	ND	4	ND	ND	ND	NR	NR	NR	NR
A2	0.2	0.019	9	ND	ND	ND	3	ND	ND	ND	NR	NR	7	NR
A3	MCB	0.028	25	ND	2	ND	ND	ND	1	ND	NR	NR	NR	NR
A4	0.2	0.031	31	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR
A5	MCB	0.004	ND	ND	ND	ND	ND	ND	4	ND	NR	NR	NR	NR
A6	MCB	0.011	10	ND	ND	ND	ND	ND	1	ND	NR	NR	NR	NR
A7	0.2	0.008	ND	ND	4	ND	2	ND	ND	NR	NR	NR	NR	NR
A8	0.5	0.278	248	ND	ND	ND	3	ND	ND	NR	NR	NR	7	NR
A9	0.7	0.083	78	2	3	ND	2	ND	ND	NR	NR	NR	NR	NR
A10	1.5	0.025	ND	ND	ND	ND	ND	ND	9	ND	7	9	ND	NR
B 11	8	4.094	ND	ND	ND	2399	ND	ND	1695	ND	NR	NR	NR	NR
B 12	MCB	0.028	ND	ND	ND	ND	10	ND	ND	NR	NR	NR	NR	NR
B 12b	MCB	0	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR	ND	ND
B 13	13	4.4	ND	ND	ND	3400	ND	ND	1000	ND	NR	NR	NR	NR
C 14	MCB	0.048	19	ND	ND	7	3	ND	19	NR	NR	NR	NR	NR
C 15	0.5	0	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR	NR
C 15a	6	3.22	ND	ND	ND	2770	ND	ND	ND	NR	NR	NR	NR	NR
C 16	MCB	0.045	18	ND	ND	11	3	ND	ND	NR	NR	NR	NR	NR
C 17	0.1	0.047	39	ND	ND	2	3	ND	ND	NR	NR	NR	NR	NR
C 18	0.1	0.049	40	ND	ND	5	4	NR	NR	NR	NR	NR	NR	NR
D 19	1	0.043	61	ND	ND	ND	2	ND	ND	NR	NR	NR	NR	NR
D 20	MCB	0	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR
D 21	MCB	0	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR
E 22	MCB	0.02	ND	ND	ND	5	ND	ND	15	ND	NR	NR	NR	NR
F 23	0.2	0.061	41	ND	ND	14	ND	ND	6	ND	NR	NR	NR	NR
F 24	MCB	0.109	14	ND	ND	92	ND	ND	3	ND	NR	NR	NR	NR
F 25	MCB	0.021	4	ND	ND	ND	<1	ND	<1	ND	NR	NR	15	NR
F 26	0.1	0	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR
F 27	MCB	0.047	2	ND	ND	44	<1	ND	ND	NR	NR	NR	NR	NR
F 28	3.5	0.3	ND	ND	ND	360	ND	ND	ND	NR	NR	NR	NR	NR
F 29	MCB	0	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR
F 30	0.1	0.037	1	ND	ND	25	2	ND	ND	NR	NR	NR	NR	NR
G 32	25	0.1	ND	11	26	ND	4	ND	2	ND	55	ND	ND	NR
G 33	2	0.478	144	ND	14	300	ND	ND	ND	NR	NR	NR	NR	NR
G 34	28	0.067	ND	7	6	30	2	ND	7	0	35	7	ND	NR
H 35	28	0.037	21	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR
H 37	26	0.182	6	ND	ND	ND	ND	ND	<1	NR	175	NR	NR	NR
H 38	10	0.245	245	ND	ND	ND	ND	0	ND	0	NR	NR	NR	NR
ZERO AIR														
		0	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR	NR	NR

(a): Retention time (sec)  
NR : Not analyzed for (Not Run)  
ND : Not Detected, <1 ppb  
0 : Detected but not quantitated

AR100146

TABLE 1 (CONTINUED)  
 HEREFORD TOWNSHIP, Hereford, PA  
 Photovac GC Screening Results, 10 MAR - 12 MAR 88

Concentrations expressed as ppb														
SAMPLE ID	NRU (ppm)	TOTAL VOLATILES (ppm)	T-1,2-DCB (34.5)	BENZENE (85)	TCE (110)	TOLUENE (219)	UNKNOWN (291)	PCE (310)	UNKNOWN (402)	ETHYL BENZENE (543)	META XYLENE (601)	O-XYLENE/STYRENE (730)	UNKNOWN (1100)	UNKNOWN (>1400)
SOIL GAS SAMPLING POINTS														
I-39	1	0.005	N	ND	ND	ND	ND	ND	ND	5	ND	NR	NR	NR
I-39N	1	0.007	N	ND	ND	ND	ND	7	ND	ND	ND	NR	NR	NR
I-40	3.5	0.052	N	ND	ND	ND	ND	ND	ND	ND	52	NR	NR	NR
I-41	0.5	0.102	N	ND	66	ND	ND	ND	36	ND	ND	ND	ND	NR
I-42	3.5	0.376	N	ND	40	ND	ND	ND	336	ND	ND	ND	ND	NR
I-43	5	0.06	N	ND	ND	ND	ND	ND	15	ND	ND	ND	ND	45
I-44	0.2	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
I-45	1	0.099	N	ND	24	ND	14	ND	ND	19	42	NR	NR	NR
I-46	0.5	0.064	N	ND	ND	12	ND	ND	9	12	11	NR	NR	NR
J-47	1.5	0.277	N	ND	3	ND	6	ND	248	9	5	6	NR	NR
J-47N	60	45.55	N	ND	ND	ND	ND	ND	290	ND	ND	ND	NR	NR
J-48	8.5	3.84	N	867	ND	1109	ND	1028	ND	NR	NR	NR	NR	NR
J-49	2	0.235	N	ND	11	ND	9	ND	150	ND	ND	ND	NR	NR
J-50	NKG	0.005	N	ND	ND	ND	ND	ND	ND	ND	15	ND	NR	NR
J-51	0.2	0.052	N	ND	ND	ND	ND	ND	47	ND	5	ND	NR	NR
J-52	2	0.123	N	ND	ND	ND	ND	ND	104	ND	ND	13	NR	NR
J-53	0.2	0.116	N	ND	ND	ND	ND	ND	41	ND	ND	ND	NR	NR
K-54	5	0.22	N	ND	ND	ND	ND	9	ND	ND	75	ND	195	ND
K-55	1	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
K-56	3.5	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR
K-57	NKG	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
K-58	0.2	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
K-59	0.2	0.942	N	ND	ND	15	ND	ND	8	ND	558	5	356	ND
K-60	NKG	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
L-61	NKG	0.049	N	ND	ND	ND	ND	ND	ND	ND	49	ND	NR	NR
L-62	0.2	0	N	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR	NR
L-63	NKG	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
L-64	0.75	0.011	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	11
M-65	0.2	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M-66	NKG	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M-67	0.3	2.655	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	2655	ND
M-68	2.5	42.124	N	ND	ND	ND	ND	ND	ND	ND	145	ND	543	41436
M-69	0.2	2.336	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	2336	ND
N-70	NKG	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-71	0.2	0.095	N	ND	ND	ND	ND	ND	ND	ND	95	NR	NR	NR
N-72	NKG	0.064	N	ND	ND	ND	ND	ND	ND	ND	ND	64	NR	NR
N-73	NKG	0.022	N	ND	ND	ND	ND	ND	ND	ND	22	ND	NR	NR
N-74	0.2	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
N-75	NKG	0.226	N	ND	ND	ND	ND	ND	ND	ND	26	NR	NR	NR
O-76	NKG	0	N	ND	ND	ND	ND	ND	NR	NR	NR	NR	NR	NR
P-77	0.2	11.123	N	ND	ND	5	ND	ND	ND	ND	ND	2083	9032	ND
P-78	NKG	0.011	N	ND	ND	ND	ND	ND	ND	11	ND	ND	NR	NR
P-79	NKG	0.127	N	ND	ND	ND	ND	ND	ND	39	ND	ND	NR	NR
P-80	NKG	0.034	N	ND	ND	ND	ND	ND	ND	34	ND	ND	NR	NR
P-81	NKG	1.929	N	ND	ND	ND	ND	ND	ND	ND	1230	699	ND	ND
P-81N	---	56.711	N	5947	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
Q-82	NKG	0.252	N	ND	ND	ND	ND	ND	ND	22	ND	230	NR	NR
Q-83	0.2	1.046	N	ND	ND	ND	ND	ND	ND	ND	1046	ND	ND	ND
Q-84	0.1	1.304	N	15	704	ND	ND	585	ND	ND	ND	ND	ND	ND
TETRAH BAG AIR SAMPLES COLLECTED FROM WELL HEADSPACE														
MJ2R	NR	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR
MJ2OR	NR	0	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NR
MJ1.108	NR	0.084	N	ND	84	ND	ND	ND	ND	ND	ND	ND	NR	NR
MJ1.208	NR	0.24	N	ND	200	ND	ND	40	ND	ND	ND	ND	NR	NR
MJ1.108	NR	2.247	N	ND	345	ND	ND	25	ND	ND	1857	ND	NR	NR
ZERO AIR	NR	0.195	N	ND	ND	ND	ND	ND	ND	ND	ND	195	ND	ND

[a]: Retention time (sec)  
 NR : Not analyzed for (Not Run)  
 ND : Not Detected, <1 ppb  
 0 : Detected but not quantitated

AR100147

APPENDIX G

SOIL GAS SURVEY: JUNE 29, 1988

AR100148

ANALYTICAL REPORT

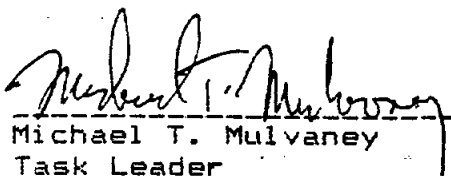
Hereford Soil Gas  
Hereford, PA

Prepared by:  
Roy F. Weston/REAC

July 7, 1988

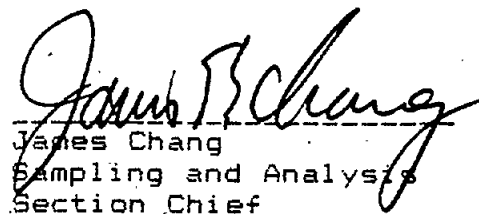
EPA Work Assignment Number: 0-14  
Weston Work Order: 3347-01-01-1014

Submitted to:  
M. Mortensen  
EPA/ERT

  
Michael T. Mulvaney  
Task Leader

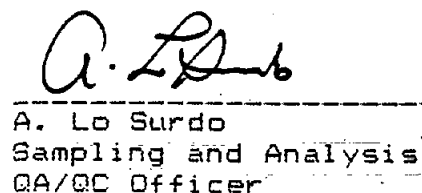
8 JUL 1988  
Date

Analysis by:  
Renata E. Wynnyk

  
James Chang  
Sampling and Analysis  
Section Chief

7/8/88  
Date

Prepared by:  
Renata E. Wynnyk

  
A. Lo Surdo  
Sampling and Analysis  
QA/QC Officer

7/7/88  
Date

Reviewed by:

A. Lo Surdo AR100149

## TABLE OF CONTENTS

### SECTION I

Introduction  
Analytical Procedures

Results of Soil Gas Analysis.....Table 1

### SECTION II

QA/QC Procedures

Results of Soil Gas Duplicate Analysis..... Table 2  
Results of Soil Gas Matrix Spike Analysis..... Table 3

### SECTION III

Calibration Range Chromatograms  
Sample Chromatograms  
QA/QC Chromatograms

### SECTION IV

Chain of Custody

AR100150

## INTRODUCTION

On June 24, 1988, REAC personnel received EPA/ERT work assignment #1014, requesting the shipment of the Photovac unit for on-site soil gas analysis at the Hereford site located in Hereford, Pennsylvania. The compounds requested for analysis were:

Trichloroethylene  
Tetrachloroethylene  
Vinyl Chloride

On June 29, 1988, the Photovac unit was transported to Pottstown, PA, where it was initially setup and calibrated. Thirteen (13) soil gas samples were received and analyzed. Also, a zero air blank, ambient air blank and a field standard were analyzed.

AR100151

#### QA/QC PROCEDURES

A duplicate analysis was performed on soil gas sample S 4. The results are listed in Table 2. Both the air sample and it's duplicate had no detectable compounds.

A matrix spike analysis was performed on soil gas sample S 6. The spike was 100 ul of sample, plus 100 ul of the calibration gas standard (spike concentration was 50 ug). The results are listed in Table 3. The spike recoveries for trichloroethylene and for vinyl chloride were 136% and 153%, respectively. The spike recovery for tetrachloroethylene was 100%.

AR100152



### ANALYTICAL PROCEDURES

The soil gas samples were analyzed on a Photovac unit, Model 10S50, utilizing a 4 foot 5% SE 30 Teflon column. The GC oven was at ambient temperature.

The air samples were analyzed by drawing 100 ul of the air sample into a gastight syringe and direct injecting onto the column. The samples were calculated using the following equation:

$$\frac{SR - K}{S} = \text{Sample Concentration}$$

SR denotes sample response

K denotes constant

S denotes slope ( X coefficient )

Sample results are listed in Table 1. No volatile compounds were detected in the soil gas samples.

AR100153

Table 1 Results of Soil Gas Analysis

Concentrations are expressed in ug

Sample Id.	Trichloroethylene	Tetrachloroethylene	Vinyl Chloride
Travel Blank	ND (25)	ND (50)	ND (25)
Ambient Air	ND (25)	ND (50)	ND (25)
S 1	ND (25)	ND (50)	ND (25)
S 2	ND (25)	ND (50)	ND (25)
S 4	ND (25)	ND (50)	ND (25)
S 5	ND (25)	ND (50)	ND (25)
S 6	ND (25)	ND (50)	ND (25)
S 7	ND (25)	ND (50)	ND (25)
R 1	ND (25)	ND (50)	ND (25)
R 2	ND (25)	ND (50)	ND (25)
R 3	ND (25)	ND (50)	ND (25)
R 4	ND (25)	ND (50)	ND (25)
R 5	ND (25)	ND (50)	ND (25)
R 6	ND (25)	ND (50)	ND (25)

ND denotes not detected.

() denote instrument detection limit.

AR100154

Table 2 Results of Soil Gas Duplicate Analysis

Compound	Conc. 1	Conc. 2	Average	Difference	% RPD
Trichloroethylene	ND	ND	--	--	--
Tetrachloroethylene	ND	ND	--	--	--
Vinyl Chloride	ND	ND	--	--	--

ND denotes not detected.

AR100155

Table 3 Results of Soil Gas Matrix Spike Analysis

Concentrations are reported in ug

Compound	Sample Conc.	Added Spike Conc.	Recovered Sample Conc.	% Recovery
Trichloroethylene	ND	50	68.1	136
Tetrachloroethylene	ND	50	50.0	100
Vinyl Chloride	ND	50	76.7	153

ND denotes not detected.

AR100156

APPENDIX H

COMPILATION OF REGION III TAT RESIDENTIAL WELL SAMPLING  
RESULTS THROUGH SPRING, 1988

AR100157

NEDEFORB TOWNSHIP GROUNDWATER SITE  
BERKS COUNTY, PA  
ANALYTICAL RESULT SUMMARY  
RESIDENTIAL WELL SAMPLING

NAME	ADDRESS/PHONE	SAMPLE DATE	TCE (PPB)	PCE (PPB)	SAMP LOC.	FLOW READING	CAUTION CHANGE	COMMENTS	WELL DEPTH (FT)
** CAMP MENSCH HILL									200
CAMP MENSCH HILL	BOX 682, RD#1, BARTO, PA 19584	05/04/83	ND	ND	-	-	-	RESIDENTIAL SAMPLING	
CAMP MENSCH HILL		08/31/83	ND	ND	-	-	-	DER SAMPLING/ANALYSIS	
CAMP MENSCH HILL		12/29/86	ND	ND	3	-	-	TAT SAMPLING-WELL	
CAMP MENSCH HILL		08/03/87	ND	ND	3	-	-	BARN, TAT SAMPLING	
CAMP MENSCH HILL		08/03/87	ND	ND	3	-	-	WASH STA., TAT SAMPLING	
** CASE, CASE,		01/22/88	ND	ND	1	-	-	FORMERLY USMISH RESIDENCE	
** CLEWER, RICHARD									85
CLEWER, RICHARD	BOX 249, RD#1, BARTO, PA 19584	09/27/83	14	ND	-	-	-	DER SAMPLING AND ANALYSIS	
CLEWER, RICHARD		12/29/86	24	ND	3	-	-	TAT SAMPLING-WELL	
CLEWER, RICHARD		01/28/87	18	ND	3	-	-	TAT SAMPLING-WELL	
CLEWER, RICHARD		02/24/87	15	1	3	-	-	CHL ANALY, TAT SAMPLING-WELL	
CLEWER, RICHARD		04/02/87	6	ND	3	-	-	KIRBY ANALY, TAT SAMPLING-WELL	
CLEWER, RICHARD		08/04/87	14	3	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	
CLEWER, RICHARD		01/19/88	14	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
** CRUM, GEORGE									43
CRUM, GEORGE	BOX 251, RD#1, BARTO, PA 19584	09/13/83	2	ND	-	-	-	DER SAMPLING AND ANALYSIS	
CRUM, GEORGE		10/31/83	1	ND	3	-	-	TAT SAMPLING-WELL	
CRUM, GEORGE		12/29/86	ND	ND	3	-	-	TAT SAMPLING-WELL	
CRUM, GEORGE		04/02/87	ND	ND	3	-	-	KIRBY ANALY: PCE-ND, PCE-MD	
CRUM, GEORGE		08/04/87	1	ND	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	
CRUM, GEORGE		01/19/88	ND	ND	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	
** DEWART, WILLIAM									UNK
DEWART, WILLIAM	BOX 244, RD#1, BARTO, PA 19584	01/21/87	ND	ND	3	-	-	SAMPLED BEFORE IRON FILTERS	
DEWART, WILLIAM		04/21/87	ND	ND	3	-	-	KIRBY ANALY, TAT SAMPLING-WELL	
DEWART, WILLIAM		08/06/87	ND	ND	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	
DEWART, WILLIAM		01/19/88	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
** FINEGAN, JAMES									UNK
FINEGAN, JAMES	BOX 243, RD#1, BARTO, PA 19584	12/29/86	155	4	3	-	-	TAT SAMPLING-WELL	
FINEGAN, JAMES		02/25/87	ND	ND	1	-	-	KIRBY ANALY-TAT SAMPLING-B/D	
FINEGAN, JAMES		02/25/87	ND	ND	2	-	-	KIRBY ANALY, TAT SAMPLING-MID	
FINEGAN, JAMES		02/25/87	588	7	3	-	-	CHL ANALYSIS, TAT SAMPLING-WELL	
FINEGAN, JAMES		04/02/87	6	14	1	000887	-	KIRBY ANALY, TAT SAMPLING-TAP	
FINEGAN, JAMES		04/02/87	55	16	2	000887	-	KIRBY: PCE-ND, PCE-MD	
FINEGAN, JAMES		04/02/87	43	28	3	000887	-	KIRBY ANALY: TCE-285, PCE-4	
FINEGAN, JAMES		05/21/87	ND	ND	1	026878	5/20/87	WASTEX ANALY, TAT SAMPLING-TAP	
FINEGAN, JAMES		05/21/87	ND	ND	2	026878	5/20/87	WASTEX ANALY, TAT SAMPLING-MID	
FINEGAN, JAMES		05/21/87	168	4	3	026878	5/20/87	WASTEX ANALY, TAT SAMPLING-WELL	
FINEGAN, JAMES		08/04/87	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	

AR100158

SENT BY: WESTON/TAT

6-13-88 3:33PM

60948267889

2016329205: # 3

HEREFORD TOWNSHIP GROUNDWATER SITE  
BERKS COUNTY, PA  
ANALYTICAL RESULT SUMMARY  
RESIDENTIAL WELL SAMPLING

NAME	ADDRESS/PHONE	SAMPLE DATE	TCE (PPB)	PCE (PPB)	SAMP LOC.	FLOW READING	CARBON CHANGE	COMMENTS	WELL DEPTH (FT)
ALDOLPH, JOHN	BOX 238, RD#1, BARTO, PA 19504	01/21/87	2	ND	3	-	-	TAT SAMPLING-MELL	UNK
ALDOLPH, JOHN		08/04/87	ND	ND	3	-	-	WASTEX ANALY, TAT SAMP-MELL	
ALDOLPH, JOHN		01/19/88	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
BERRY, B.E.	BOX 342, RD#1, BARTO, PA 19504	07/13/83	460	4	-	-	-	DER SAMPLING	UNK
BERRY, B.E.		10/19/83	ND	ND	1	-	-	TAT SAMPLING-TAP	
BERRY, B.E.		10/19/83	460	1	3	-	-	TAT SAMPLING-MELL	
BERRY, B.E.		10/31/83	465	ND	3	-	-	TAT SAMPLING-MELL	
BERRY, B.E.		01/19/87	ND	ND	1	20485	01/15/87	TAT SAMPLING-TAP	
BERRY, B.E.		01/19/87	ND	ND	2	20483	01/15/87	TAT SAMPLING-MID	
BERRY, B.E.		01/19/87	120	ND	3	20483	01/15/87	TAT SAMPLING-MELL	
BERRY, B.E.		02/26/87	ND	ND	1	2529.1	01/15/87	KIRBY ANALY, TAT SAMPLING-TAP	
BERRY, B.E.		02/26/87	ND	ND	2	2529.1	01/15/87	KIRBY ANALY, TAT SAMPLING-MID	
BERRY, B.E.		02/26/87	325	6	3	2529.1	01/15/87	CAL ANALY, TAT SAMPLING-MELL	
BERRY, B.E.		04/02/87	ND	ND	1	0030574	01/15/87	KIRBY ANALY, TAT SAMPLING-TAP	
BERRY, B.E.		04/02/87	25	7	2	0030374	-	KIRBY ANALY: ICE-MD, PCE-MD	
BERRY, B.E.		04/02/87	294	11	3	0030374	-	KIRBY ANALY, TAT SAMPLING-MELL	
BERRY, B.E.		05/20/87	ND	ND	1	0037346	5/20/87	WASTEX ANALY, TAT SAMPLING-TAP	
BERRY, B.E.		05/20/87	ND	ND	2	0037346	5/20/87	WASTEX ANALY, TAT SAMPLING-MID	
BERRY, B.E.		05/20/87	84	2	3	0037346	5/20/87	WASTEX ANALY, TAT SAMPLING-MELL	
BERRY, B.E.		08/03/87	ND	ND	1	-	-	WASTEX ANALY, TAT SAMP-TAP	
BERRY, B.E.		08/03/87	ND	ND	2	-	-	WASTEX ANALY, TAT SAMP-MID	
BERRY, B.E.		08/03/87	59	2	3	-	-	WASTEX ANALY, TAT SAMP-MELL	
BERRY, B.E.		08/31/87	ND	ND	1	0050312	8/28/87	WASTEX ANALY, TAT SAMPLING-TAP	
BERRY, B.E.		08/31/87	ND	ND	2	0050312	8/28/87	WASTEX ANALY, TAT SAMPLING-MID	
BERRY, B.E.		08/31/87	348	5	3	0050312	8/28/87	WASTEX ANALY, TAT SAMPLING-MELL	
BERRY, B.E.		12/06/87	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
BERRY, B.E.		12/06/87	ND	ND	2	-	-	WASTEX ANALY, TAT SAMPLING-MID	
BERRY, B.E.		12/06/87	279	12	3	-	-	WASTEX ANALY, TAT SAMPLING-MELL	
BERRY, B.E.		01/20/88	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
BERRY, B.E.		01/20/88	ND	ND	2	-	-	WASTEX ANALY, TAT SAMPLING-MID	
BERRY, B.E.		01/20/88	350	2	3	-	-	WASTEX ANALY, TAT SAMPLING-MELL	
BERRY, B.E.		03/03/88	ND	ND	1	0079376	12/87	WASTEX ANALY, TAT SAMPLING-MELL	
BERRY, B.E.		03/03/88	ND	ND	2	0079376	12/87	WASTEX ANALY, TAT SAMPLING-MID	
BERRY, B.E.		03/03/88	213	6	3	0079376	12/87	WASTEX ANALY, TAT SAMPLING-MELL	

WERNERD TOWNSHIP GROUNDWATER SITE  
BERKS COUNTY, PA  
ANALYTICAL RESULTS SUMMARY  
RESIDENTIAL WELL SAMPLING

NAME	ADDRESS/PHONE	SAMPLE DATE	ICE (PPM)	PCE (PPM)	SAMP LOC.	FLOW REMARKS	CARBON CHANGE	COMMENTS	WELL DEPTH (FT)
FINEGAN, JAMES		08/04/87	ND	ND	2	-	-	WASTEX ANALY, TAT SAMP-MID	
FINEGAN, JAMES		08/04/87	427	21	3	-	-	WASTEX ANALY, TAT SAMP-WELL	
FINEGAN, JAMES		08/31/87	ND	ND	1	069960	8/28/87	WASTEX ANALY, TAT SAMPLING-TAP	
FINEGAN, JAMES		08/31/87	ND	ND	2	069968	8/28/87	WASTEX ANALY, TAT SAMPLING-MID	
FINEGAN, JAMES		08/31/87	2057	709	3	069968	8/28/87	WASTEX ANALY, TAT SAMPLING-WELL	
FINEGAN, JAMES		12/04/87	ND	ND	1	938283	12/03/87	WASTEX ANALY, TAT SAMPLING-TAP	
FINEGAN, JAMES		12/04/87	ND	ND	2	938203	12/03/87	WASTEX ANALY, TAT SAMPLING-MID	
FINEGAN, JAMES		12/04/87	1654	11	3	938203	12/03/87	WASTEX ANALY, TAT SAMPLING-WELL	
FINEGAN, JAMES		01/19/88	ND	ND	1	-	12/03/87	WASTEX ANALY, TAT SAMPLING-TAP	
FINEGAN, JAMES		01/19/88	ND	ND	2	-	12/03/87	WASTEX ANALY, TAT SAMPLING-MID	
FINEGAN, JAMES		01/19/88	571	6	3	-	12/03/87	WASTEX ANALY, TAT SAMPLING-WELL	
FINEGAN, JAMES		03/03/88	ND	ND	1	113768	12/87	WASTEX ANALY, TAT SAMPLING-TAP	
FINEGAN, JAMES		03/03/88	ND	ND	2	113768	12/87	WASTEX ANALY, TAT SAMPLING-MID	
FINEGAN, JAMES		03/03/88	320	4	3	113768	12/87	WASTEX ANALY, TAT SAMPLING-WELL	
FLANNERY, DAVID	BOX 267, RD#1, GARTO, PA 19504	12/29/86	154	4	3	-	-	TAT SAMPLING-WELL	
FLANNERY, DAVID		01/28/87	ND	ND	1	-	YES	TAT SAMPLING-TAP	
FLANNERY, DAVID		02/04/87	41	ND	1	-	-	TAT SAMPLING-TAP	
FLANNERY, DAVID		02/25/87	ND	ND	1	-	02/25/87	KIRBY ANALY, TAT SAMPLING-TAP	
FLANNERY, DAVID		02/25/87	ND	ND	2	-	02/25/87	KIRBY ANALY, TAT SAMPLING-MID	
FLANNERY, DAVID		02/25/87	530	6	3	-	02/25/87	CRL ANALY, TAT SAMPLING-WELL	
FLANNERY, DAVID		04/02/87	ND	ND	1	010334	-	KIRBY ANALY, TAT SAMPLING-TAP	
FLANNERY, DAVID		04/02/87	ND	ND	2	010334	-	KIRBY ANALY, TAT SAMPLING-MID	
FLANNERY, DAVID		04/02/87	339	9	3	010334	-	KIRBY ANALY, TAT SAMPLING-WELL	
FLANNERY, DAVID		05/21/87	ND	ND	1	-	5/20/87	WASTEX ANALY, TAT SAMPLING-TAP	
FLANNERY, DAVID		05/21/87	ND	ND	2	-	5/20/87	WASTEX ANALY, TAT SAMPLING-MID	
FLANNERY, DAVID		05/21/87	18	1	3	-	5/20/87	WASTEX ANALY, TAT SAMPLING-WELL	
FLANNERY, DAVID		08/04/87	ND	ND	1	-	-	WASTEX ANALY, TAT SAMP-TAP	
FLANNERY, DAVID		08/04/87	1	ND	2	-	-	WASTEX ANALY, TAT SAMP-MID	
FLANNERY, DAVID		08/04/87	304	18	3	-	-	WASTEX ANALY, TAT SAMP-WELL	
FLANNERY, DAVID		08/31/87	ND	ND	1	8355980	8/28/87	WASTEX ANALY, TAT SAMPLING-TAP	
FLANNERY, DAVID		08/31/87	ND	ND	2	8355980	8/28/87	WASTEX ANALY, TAT SAMPLING-MID	
FLANNERY, DAVID		08/31/87	21	ND	3	835590	8/28/87	WASTEX ANALY, TAT SAMPLING-WELL	
FLANNERY, DAVID		12/04/87	ND	ND	1	8497908	12/03/87	WASTEX ANALY, TAT SAMPLING-TAP	
FLANNERY, DAVID		12/04/87	ND	ND	2	8497908	12/03/87	WASTEX ANALY, TAT SAMPLING-MID	
FLANNERY, DAVID		12/04/87	585	5	3	8497908	12/03/87	WASTEX ANALY, TAT SAMPLING-WELL	
FLANNERY, DAVID		01/20/88	ND	ND	1	-	12/03/87	WASTEX ANALY, TAT SAMPLING-TAP	
FLANNERY, DAVID		01/20/88	ND	ND	2	-	12/03/87	WASTEX ANALY, TAT SAMPLING-MID	
FLANNERY, DAVID		01/20/88	239	ND	3	-	12/03/87	WASTEX ANALY, TAT SAMPLING-WELL	
FLANNERY, DAVID		03/03/88	ND	ND	1	863265	12/87	WASTEX ANALY, TAT SAMPLING-TAP	
FLANNERY, DAVID		03/03/88	ND	ND	2	863265	12/87	WASTEX ANALY, TAT SAMPLING-MID	
FLANNERY, DAVID		03/03/88	343	4	3	863265	12/87	WASTEX ANALY, TAT SAMPLING-WELL	
FRONZISER, JAMES	BOX 401 CAMP MENSCH MILL	10/19/83	ND	ND	1	-	-	TAT SAMPLING-TAP	



HEREFORD TOWNSHIP GROUNDWATER SITE  
BERKS COUNTY, PA  
ANALYTICAL RESULT SUMMARY  
RESIDENTIAL WELL SAMPLING

NAME	ADDRESS/PHONE	SAMPLE DATE	TOE (PPH)	PCE (PPH)	SAMP LOC.	FLOW READING	CARBON CHANCE	COMMENTS	WELL DEPTH (FT)
FROMEISEN, JAMES		10/31/83	ND	ND	1	-	-	TAT SAMPLING-TAP	UNK
FROMEISEN, JAMES		12/29/86	ND	ND	3	-	-	TAT SAMPLING-WELL	UNK
FROMEISEN, JAMES		09/03/87	ND	ND	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	UNK
FROMEISEN, JAMES		01/20/88	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	UNK
GRATER, EDWARD									
GRATER, EDWARD	BOX 400 LONG LA, BARTO PA 19504	12/29/86	ND	ND	3	-	-	TAT SAMPLING-WELL	UNK
GRATER, EDWARD		08/06/87	ND	ND	3	-	-	WASTEX ANALY, TAT SAMP-WELL	UNK
GRATER, EDWARD		01/19/88	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	UNK
HOFFMEISTER, JOHN									
HOFFMEISTER, JOHN	BOX 481, RD#1, BARTO, PA 19504	01/21/87	ND	ND	3	-	-	TAT SAMPLING-WELL	UNK
HOFFMEISTER, JOHN		08/04/87	ND	ND	3	-	-	WASTEX ANALY, TAT SAMP-WELL	UNK
HOFFMEISTER, JOHN		01/19/88	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	UNK
JOHNSON, CHESTER									
JOHNSON, CHESTER	BOX 343, RD#1, BARTO, PA 19504	09/13/83	160	2	-	-	-	DER SAMPLING AND ANALYSIS	UNK
JOHNSON, CHESTER		10/31/83	200	ND	1	-	-	TAT SAMPLING-TAP	UNK
JOHNSON, CHESTER		09/18/86	880	ND	3	-	-	TAT SAMPLING--AT THE WELL	UNK
JOHNSON, CHESTER		11/12/86	415	ND	3	-	-	TAT SAMPLING--AT THE WELL	UNK
JOHNSON, CHESTER		01/19/87	ND	ND	1	43549	01/16/87	VOL CRGS DETECTED AT TAP.	UNK
JOHNSON, CHESTER		01/19/87	ND	ND	2	43549	01/16/87	KIRBY ANALY, TAT SAMPLING-MID	UNK
JOHNSON, CHESTER		01/19/87	121	ND	3	43549	01/16/87	KIRBY ANALY, TAT SAMPLING-WELL	UNK
JOHNSON, CHESTER		01/28/87	ND	ND	1	44560	01/27/87	KIRBY ANALY, TAT SAMPLING-TAP	UNK
JOHNSON, CHESTER		01/28/87	ND	ND	2	44560	01/27/87	KIRBY ANALY, TAT SAMPLING-MID	UNK
JOHNSON, CHESTER		01/28/87	124	2	3	44560	01/27/87	KIRBY ANALY, TAT SAMPLING-WELL	UNK
JOHNSON, CHESTER		02/25/87	16	ND	1	4742.7	01/27/87	KIRBY ANALY, TAT SAMPLING-TAP	UNK
JOHNSON, CHESTER		02/25/87	350	4	3	4742.7	01/27/87	KIRBY ANALY, TAT SAMPLING-MID	UNK
JOHNSON, CHESTER		03/25/87	20	ND	1	-	-	CELL ANALY, TAT SAMPLING-WELL	UNK
JOHNSON, CHESTER		04/03/87	13	ND	1	005281	-	KIRBY ANALY, TAT SAMPLING-TAP	UNK
JOHNSON, CHESTER		04/03/87	26	ND	2	005281	-	KIRBY ANALY, TAT SAMPLING-MID	UNK
JOHNSON, CHESTER		04/03/87	313	ND	3	005281	-	KIRBY ANALY, TAT SAMPLING-WELL	UNK
JOHNSON, CHESTER		05/20/87	ND	ND	1	-	5/20/87	WASTEX ANALY, TAT SAMPLING-TAP	UNK
JOHNSON, CHESTER		05/20/87	ND	ND	2	-	5/20/87	WASTEX ANALY, TAT SAMPLING-MID	UNK
JOHNSON, CHESTER		05/20/87	90	1	3	-	5/20/87	WASTEX ANALY, TAT SAMPLING-WELL	UNK
JOHNSON, CHESTER		06/03/87	ND	ND	1	-	-	WASTEX ANALY, TAT SAMP-TAP	UNK
JOHNSON, CHESTER		06/03/87	ND	ND	2	-	-	WASTEX ANALY, TAT SAMP-MID	UNK
JOHNSON, CHESTER		06/03/87	248	1	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	UNK
JOHNSON, CHESTER		12/04/87	ND	ND	1	78715	12/03/87	WASTEX ANALY, TAT SAMPLING-TAP	UNK
JOHNSON, CHESTER		12/04/87	ND	ND	2	78715	12/03/87	WASTEX ANALY, TAT SAMPLING-MID	UNK
JOHNSON, CHESTER		12/04/87	476	3	3	78715	12/03/87	WASTEX ANALY, TAT SAMPLING-WELL	UNK
JOHNSON, CHESTER		01/19/88	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	UNK
JOHNSON, CHESTER		01/19/88	ND	ND	2	-	-	WASTEX ANALY, TAT SAMPLING-MID	UNK
JOHNSON, CHESTER		01/19/88	158	ND	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	UNK
JOHNSON, CHESTER		03/04/88	ND	ND	1	0088092	12/87	WASTEX ANALY, TAT SAMPLING-TAP	UNK

AR100161

SENT BY: WESTON/TBT

6-13-88 3:35PM

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HEREFORD TOWNSHIP GROUNDWATER SITE  
BERKS COUNTY, PA  
ANALYTICAL RESULT SUMMARY  
RESIDENTIAL WELL SAMPLING

NAME ADDRESS/PHONE

SAMPLE DATE

ICE (PPB)

PCE (PPB)

SAMP LNC.

FLOW MENDING

CARBON CHANGE

COMMENTS

WELL DEPTH (FT)

JOHNSON, CHESTER  
JOHNSON, CHESTER

444 MCKEON, THOMAS (KAROLESKY)  
BOX 267, RD#1, BARTO, PA 19504

WASTEX ANALY, TAT SAMPLING-MID  
WASTEX ANALY, TAT SAMPLING-MELL

MCKEON, THOMAS	12/29/86	162	ND	ND	2	000092	12/87	WASTEX ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	02/03/87	186	ND	ND	3	000092	12/87	WASTEX ANALY, TAT SAMPLING-MELL
MCKEON, THOMAS	02/24/87	ND	ND	ND	1	0022911	-	TAT SAMPLING-MELL
MCKEON, THOMAS	02/24/87	ND	ND	ND	2	-	02/24/87	KIRBY ANALY, TAT SAMPLING-TAP
MCKEON, THOMAS	02/24/87	160	2	2	3	-	02/24/87	KIRBY ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	04/03/87	ND	ND	ND	1	002911	-	KIRBY ANALY, TAT SAMPLING-TAP
MCKEON, THOMAS	04/03/87	21	ND	ND	2	002911	-	KIRBY ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	05/21/87	ND	ND	ND	1	0064955	5/20/87	WASTEX ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	05/21/87	ND	ND	ND	2	0064955	5/20/87	WASTEX ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	05/21/87	103	1	1	3	0064955	5/20/87	WASTEX ANALY, TAT SAMPLING-MELL
MCKEON, THOMAS	08/04/87	ND	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	08/04/87	ND	ND	ND	2	-	-	WASTEX ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	08/04/87	3236	6	3	3	-	-	WASTEX ANALY, TAT SAMPLING-MELL
MCKEON, THOMAS	08/31/87	2	ND	ND	1	016770	8/28/87	WASTEX ANALY, TAT SAMPLING-TAP
MCKEON, THOMAS	08/31/87	ND	ND	ND	2	016770	8/28/87	WASTEX ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	08/31/87	1008	24	24	3	016770	8/28/87	WASTEX ANALY, TAT SAMPLING-MELL
MCKEON, THOMAS	12/09/87	ND	ND	ND	1	0233789	12/03/87	WASTEX ANALY, TAT SAMPLING-TAP
MCKEON, THOMAS	12/09/87	ND	ND	ND	2	0233789	12/03/87	WASTEX ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	12/09/87	229	5	3	3	0233789	12/03/87	WASTEX ANALY, TAT SAMPLING-MELL
MCKEON, THOMAS	01/19/88	ND	ND	ND	1	-	12/03/87	WASTEX ANALY, TAT SAMPLING-TAP
MCKEON, THOMAS	01/19/88	ND	ND	ND	2	-	12/03/87	WASTEX ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	01/19/88	197	ND	ND	3	-	12/03/87	WASTEX ANALY, TAT SAMPLING-MELL
MCKEON, THOMAS	03/03/88	ND	ND	ND	1	029248	12/87	WASTEX ANALY, TAT SAMPLING-TAP
MCKEON, THOMAS	03/03/88	ND	ND	ND	2	029248	12/87	WASTEX ANALY, TAT SAMPLING-MID
MCKEON, THOMAS	03/03/88	914	9	3	3	029248	12/87	WASTEX ANALY, TAT SAMPLING-MELL

444 WEITZLER, JAMES

BOX 446, RD#1, BARTO, PA 19504

DER SAMPLING AND ANALYSIS

175

WEITZLER, JAMES	09/27/83	130	ND	ND	-	-	-	TAT SAMPLING
WEITZLER, JAMES	10/19/83	ND	ND	ND	-	-	-	TAT SAMPLING-MELL
WEITZLER, JAMES	10/31/83	280	ND	ND	3	-	-	TAT SAMPLING-MELL
WEITZLER, JAMES	09/18/86	510	ND	ND	3	-	-	TAT SAMPLING-MELL
WEITZLER, JAMES	11/12/86	658	5	3	3	-	-	TAT SAMPLING-MELL
WEITZLER, JAMES	01/19/87	ND	ND	ND	1	32736	01/16/87	1998 CHLOROFORM AT TAP-RESID.
WEITZLER, JAMES	01/19/87	ND	ND	ND	2	32736	01/16/87	KIRBY ANALY, TAT SAMPLING-MID
WEITZLER, JAMES	01/19/87	127	ND	ND	3	32736	01/16/87	KIRBY ANALY, TAT SAMPLING-MELL
WEITZLER, JAMES	02/25/87	ND	ND	ND	1	3445	01/16/87	KIRBY ANALY, TAT SAMPLING-TAP
WEITZLER, JAMES	02/25/87	ND	ND	ND	2	3445	01/16/87	KIRBY ANALY, TAT SAMPLING-MID
WEITZLER, JAMES	02/25/87	500	5	3	3	3445	01/16/87	KIRBY ANALY, TAT SAMPLING-MELL
WEITZLER, JAMES	04/03/87	66	ND	ND	1	0034465	-	KIRBY ANALY, TAT SAMPLING-TAP
WEITZLER, JAMES	04/03/87	32	ND	ND	2	0034465	-	KIRBY ANALY, TAT SAMPLING-MID
WEITZLER, JAMES	04/03/87	376	ND	ND	3	0034465	-	KIRBY ANALY, TAT SAMPLING-MELL
WEITZLER, JAMES	05/20/87	ND	ND	ND	1	0039742	5/20/87	WASTEX ANALY, TAT SAMPLING-MELL

HEREFORD TOWNSHIP GROUNDWATER SITE  
BERKS COUNTY, PA  
ANALYTICAL RESULT SUMMARY  
RESIDENTIAL WELL SAMPLING

NAME	ADDRESS/PHONE	SAMPLE DATE	TCE (PPB)	PCE (PPB)	SAMP LOC.	FLOW READING	CARBON CHANGE	COMMENTS	WELL DEPTH (FT)
WEITZLER, JAMES		05/20/87	ND	ND	2	0039742	5/20/87	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, JAMES		05/20/87	170	2	3	0039742	5/20/87	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, JAMES		08/03/87	ND	ND	1	-	-	WASTEX ANALY, TAT SAMP-TAP	
WEITZLER, JAMES		08/03/87	ND	ND	2	-	-	WASTEX ANALY, TAT SAMP-MID	
WEITZLER, JAMES		08/03/87	382	6	3	-	-	WASTEX ANALY, TAT SAMP-MID	
WEITZLER, JAMES		08/31/87	ND	ND	1	0047941	8/28/87	WASTEX ANALY, TAT SAMPLING-TAP	
WEITZLER, JAMES		08/31/87	1	ND	2	0047941	8/28/87	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, JAMES		08/31/87	414	16	3	0047941	8/28/87	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, JAMES		01/20/88	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WEITZLER, JAMES		01/20/88	ND	ND	2	-	-	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, JAMES		01/20/88	551	ND	3	-	-	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, JAMES		03/03/88	ND	ND	1	0058062	12/87	WASTEX ANALY, TAT SAMPLING-TAP	
WEITZLER, JAMES		03/03/88	ND	ND	2	0058062	12/87	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, JAMES		03/03/88	519	7	3	0058062	12/87	WASTEX ANALY, TAT SAMPLING-MID	

\*\* WEITZLER, KATIE

BOX 405, RD#1, BARTO, PA 19504

WEITZLER, KATIE	09/19/83	8500	110	-	-	-	-	DER SAMPLING AND ANALYSIS	250
WEITZLER, KATIE	10/19/83	1600	670	-	-	-	-	TAT SAMPLING	
WEITZLER, KATIE	10/31/83	10,500	160	-	-	-	-	TAT SAMPLING	
WEITZLER, KATIE	09/18/84	19,000	200	3	-	-	-	TAT SAMPLING-MID	
WEITZLER, KATIE	11/13/86	8,046	ND	3	-	-	-	TAT SAMPLING-MID	
WEITZLER, KATIE	01/15/87	ND	ND	1	-	-	-	KIRBY ANALY, TAT SAMPLING-TAP	
WEITZLER, KATIE	01/15/87	ND	ND	2	-	-	-	KIRBY ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	01/19/87	ND	ND	1	-	-	-	KIRBY ANALY, TAT SAMPLING-TAP	
WEITZLER, KATIE	01/19/87	ND	ND	2	-	-	-	KIRBY ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	01/19/87	748	70	3	-	-	-	KIRBY ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	02/26/87	6000	160	3	-	-	-	CAL ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	04/02/87	11	5	1	-	-	-	KIRBY ANALY: TCE-426, PCE-6	
WEITZLER, KATIE	04/02/87	327	10	2	-	-	-	KIRBY ANALY: TCE-ND, PCE-ND	
WEITZLER, KATIE	04/02/87	882	10	3	-	-	-	KIRBY ANALY: TCE-4950, PCE-63	
WEITZLER, KATIE	04/21/87	ND	ND	1	-	-	-	TAT SAMPLING-TAP	
WEITZLER, KATIE	04/21/87	ND	ND	2	-	-	-	TAT SAMPLING-MID	
WEITZLER, KATIE	04/21/87	6300	90	3	-	-	-	TAT SAMPLING-MID	
WEITZLER, KATIE	05/21/87	ND	ND	1	-	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WEITZLER, KATIE	05/21/87	ND	ND	2	-	-	-	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	05/21/87	255	52	3	-	-	-	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	06/03/87	ND	ND	1	-	-	-	CHLOROFORM-3PPB	
WEITZLER, KATIE	06/03/87	ND	ND	2	-	-	-	WASTEX ANALY, TAT SAMP-MID	
WEITZLER, KATIE	06/03/87	3222	78	3	-	-	-	WASTEX ANALY, TAT SAMP-MID	
WEITZLER, KATIE	08/31/87	ND	ND	1	-	-	-	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	08/31/87	5	ND	2	-	-	-	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	08/31/87	5760	187	3	-	-	-	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	12/04/87	ND	ND	1	-	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WEITZLER, KATIE	12/04/87	ND	ND	2	-	-	-	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	12/04/87	5494	122	3	-	-	-	WASTEX ANALY, TAT SAMPLING-MID	
WEITZLER, KATIE	01/20/88	ND	ND	1	-	-	-	WASTEX ANALY, TAT SAMPLING-TAP	

AR100163

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WEREFORD TOWNSHIP GROUNDWATER SITE  
BERKS COUNTY, PA  
ANALYTICAL RESULT SUMMARY  
RESIDENTIAL WELL SAMPLING

NAME	ADDRESS/PHONE	SAMPLE DATE	TCE (PPB)	ACE (PPB)	SAMP LOC.	FLOW READING	CARBON CHANGE	COMMENTS	WELL DEPTH (FT)
NETTZLER, KATIE		01/20/88	ND	1	2		12/03/87	WASTEX ANALY, TAT SAMPLING-HID	
NETTZLER, KATIE		01/20/88	6,825	238	3		12/03/87	WASTEX ANALY, TAT SAMPLING-HID	
NETTZLER, KATIE		03/03/88	ND	ND	1	0091451	12/87	WASTEX ANALY, TAT SAMPLING-TAP	
NETTZLER, KATIE		03/03/88	ND	ND	2	0091451	12/87	WASTEX ANALY, TAT SAMPLING-HID	
NETTZLER, KATIE		03/03/88	2531	19	3	0091451	12/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE	BOX 346, RD#1, BARTO, PA 19504	10/31/83	ND	ND	1			TAT SAMPLING-TAP	UNK
MILLER, GEORGE		10/31/83	83	ND	3			TAT SAMPLING-HID	
MILLER, GEORGE		12/29/86	2	ND	1			TAT SAMPLING-TAP	
MILLER, GEORGE		02/25/87	123	4	1			KIRBY ANALY, TAT SAMPLING-TAP	
MILLER, GEORGE		02/25/87	380	7	3			KIRBY ANALY, TAT SAMPLING-TAP	
MILLER, GEORGE		04/03/87	41	ND	1			KIRBY ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		04/03/87	286	ND	3			KIRBY ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		04/21/87	ND	ND	1	147708	4/21/87	FILTERS INSTALLED THIS DATE	
MILLER, GEORGE		04/21/87	ND	ND	2	147708	4/21/87	FILTERS INSTALLED THIS DATE	
MILLER, GEORGE		05/25/87	440	5	3	147708	4/21/87	FILTERS INSTALLED THIS DATE	
MILLER, GEORGE		05/25/87	ND	ND	1	009565	5/20/87	WASTEX ANALY, TAT SAMPLING-TAP	
MILLER, GEORGE		05/25/87	ND	ND	2	009565	5/20/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		05/25/87	166	3	3	009565	5/20/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		06/06/87	ND	ND	1			WASTEX ANALY, TAT SAMPLING-TAP	
MILLER, GEORGE		06/06/87	ND	ND	2			WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		06/06/87	304	ND	3			WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		09/16/87	ND	ND	1	037583	8/20/87	WASTEX ANALY, TAT SAMPLING-TAP	
MILLER, GEORGE		09/16/87	ND	ND	2	037583	8/20/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		09/16/87	424	6	3	037583	8/20/87	WASTEX ANALY, TAT SAMPLING-TAP	
MILLER, GEORGE		12/04/87	ND	ND	1	578708	12/08/87	WASTEX ANALY, TAT SAMPLING-TAP	
MILLER, GEORGE		12/04/87	ND	ND	2	578708	12/08/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		12/04/87	586	11	3	578708	12/08/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		01/19/88	ND	ND	1		12/08/87	WASTEX ANALY, TAT SAMPLING-TAP	
MILLER, GEORGE		01/19/88	ND	ND	2		12/08/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		01/19/88	4,000	26	3		12/08/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		03/03/88	ND	ND	1	0823515	12/87	WASTEX ANALY, TAT SAMPLING-TAP	
MILLER, GEORGE		03/03/88	ND	ND	2	0823515	12/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, GEORGE		03/03/88	354	5	3	0823515	12/87	WASTEX ANALY, TAT SAMPLING-HID	
MILLER, LOUISE	BOX 481, RD#1, BARTO, PA 19504	01/21/87	ND	ND				PROPERTY OWNED BY MOFFETTER	UNK
MILLER, LOUISE		08/04/87	ND	ND	3			WASTEX ANALY, TAT SAMPLING-HID	
MILLER, LOUISE		01/19/88	ND	ND	1			WASTEX ANALY, TAT SAMPLING-TAP	
NOTER, KEN	RD#1, BARTO, PA 19504	04/02/87	584	21	3			KIRBY ANALY: TCE-700, PCE-36	125
NOTER, KEN		05/25/87	ND	ND	1	001822	5/20/87	WASTEX ANALY, TAT SAMPLING-TAP	
NOTER, KEN		05/25/87	ND	ND	2	001822	5/25/87	WASTEX ANALY, TAT SAMPLING-HID	
NOTER, KEN		05/25/87	3	169	3	001822	5/20/87	WASTEX ANALY, TAT SAMPLING-HID	

NEERFORD TOWNSHIP GROUNDWATER SITE  
BERKS COUNTY, PA  
ANALYTICAL RESULT SUMMARY  
RESIDENTIAL WELL SAMPLING

NAME	ADDRESS/PHONE	SAMPLE DATE	ICE (PPM)	POE (PPM)	SAMP LOC.	FLOW READING	CARBON CHANGE	COMMENTS	WELL DEPTH (FT)
MOYER, KEN		06/04/87	ND	ND	1	-	-	WASTEX ANALY, TAT SAMP-TAP	
MOYER, KEN		06/04/87	ND	ND	2	-	-	WASTEX ANALY, TAT SAMP-MID	
MOYER, KEN		08/04/87	1042	19	3	-	-	WASTEX ANALY, TAT SAMP-UELL	
MOYER, KEN		08/31/87	ND	ND	1	009530	8/28/87	WASTEX ANALY, TAT SAMPING-TAP	
MOYER, KEN		08/31/87	2	ND	2	009530	8/28/87	WASTEX ANALY, TAT SAMPING-MID	
MOYER, KEN		08/31/87	3942	40	3	009530	8/28/87	WASTEX ANALY, TAT SAMPING-WELL	
MOYER, KEN		12/04/87	ND	ND	1	-	12/03/87	WASTEX ANALY, TAT SAMPING-TAP	
MOYER, KEN		12/04/87	ND	ND	2	-	12/03/87	WASTEX ANALY, TAT SAMPING-MID	
MOYER, KEN		12/04/87	493	6	3	-	12/03/87	WASTEX ANALY, TAT SAMPING-WELL	
MOYER, KEN		01/19/88	ND	ND	1	-	12/03/87	WASTEX ANALY, TAT SAMPING-TAP	
MOYER, KEN		01/19/88	ND	ND	2	-	12/03/87	WASTEX ANALY, TAT SAMPING-MID	
MOYER, KEN		01/19/88	927	9	3	-	12/03/87	WASTEX ANALY, TAT SAMPING-WELL	
MOYER, KEN		03/04/88	ND	ND	1	023278	12/87	WASTEX ANALY, TAT SAMPING-TAP	
MOYER, KEN		03/04/88	ND	ND	2	023278	12/87	WASTEX ANALY, TAT SAMPING-MID	
MOYER, KEN		03/04/88	773	48	3	023278	12/87	WASTEX ANALY, TAT SAMPING-WELL	
OPPETT, MICHAEL	BOX 255, RD#1, BARTO, PA 19504	08/31/87	ND	ND	3	-	-	WASTEX ANALY, TAT SAMPING-WELL	
OPPETT, MICHAEL									
SANZO, JAN	BOX 155, RD#1, BARTO, PA 19504	01/23/85	373	ND	-	-	-	WASTEX ANALYSIS	
SANZO, JAN		12/29/86	101	ND	3	-	-	TAT SAMPING-WELL	
SANZO, JAN		02/25/87	119	3	-	-	-	TAT SAMPING-GARAGE	
SANZO, JAN		02/25/87	120	2	-	-	-	TAT SAMPING-SPRING HOUSE	
SANZO, JAN		02/25/87	ND	ND	1	-	02/25/87	KIRBY ANALY, TAT SAMPING-TAP	
SANZO, JAN		02/25/87	ND	ND	2	-	02/25/87	KIRBY ANALY, TAT SAMPING-MID	
SANZO, JAN		02/25/87	195	3	3	-	02/25/87	CEL ANALY, TAT SAMPING-WELL	
SANZO, JAN		04/03/87	64	ND	1	002092	-	KIRBY ANALY, TAT SAMPING-TAP	
SANZO, JAN		04/03/87	ND	ND	1	002092	-	KIRBY ANALY, TAT SAMPING-TAP	
SANZO, JAN		04/03/87	ND	ND	2	002092	-	KIRBY ANALY, TAT SAMPING-MID	
SANZO, JAN		05/25/87	ND	ND	1	006741	5/20/87	WASTEX ANALY, TAT SAMPING-TAP	
SANZO, JAN		05/25/87	ND	ND	2	006741	5/20/87	WASTEX ANALY, TAT SAMPING-MID	
SANZO, JAN		05/25/87	6	ND	3	006741	5/20/87	WASTEX ANALY, TAT SAMPING-WELL	
SANZO, JAN		06/03/87	ND	ND	2	-	-	WASTEX ANALY, TAT SAMPING-MID	
SANZO, JAN		06/04/87	37	1	-	-	-	WASTEX ANALY, TAT SAMP-SPRING	
SANZO, JAN		06/06/87	ND	ND	1	-	-	WASTEX ANALY, TAT SAMPING-TAP	
SANZO, JAN		06/06/87	219	ND	3	-	-	WASTEX ANALY, TAT SAMPING-WELL	
SANZO, JAN		12/06/87	ND	ND	1	0295005	11/20/87	WASTEX ANALY, TAT SAMPING-TAP	
SANZO, JAN		12/06/87	ND	ND	2	0295005	11/20/87	WASTEX ANALY, TAT SAMPING-MID	
SANZO, JAN		12/06/87	152	7	3	0295005	11/20/87	WASTEX ANALY, TAT SAMPING-WELL	
SANZO, JAN		01/22/88	ND	ND	1	-	11/20/87	WASTEX ANALY, TAT SAMPING-TAP	
SANZO, JAN		01/22/88	ND	ND	2	-	11/20/87	WASTEX ANALY, TAT SAMPING-MID	
SANZO, JAN		01/22/88	172	ND	3	-	11/20/87	WASTEX ANALY, TAT SAMPING-WELL	
SANZO, JAN		03/04/88	ND	ND	1	040105	12/87	WASTEX ANALY, TAT SAMPING-TAP	
SANZO, JAN		03/04/88	ND	ND	2	040105	12/87	WASTEX ANALY, TAT SAMPING-MID	
SANZO, JAN		03/04/88	109	1	3	040105	12/87	WASTEX ANALY, TAT SAMPING-WELL	

AR100165

BEREFORD TOWNSHIP GROUNDWATER SITE  
BERKS COUNTY, PA  
ANALYTICAL RESULT SUMMARY  
RESIDENTIAL WELL SAMPLING

NAME	ADDRESS/PHONE	SAMPLE DATE	TOE (PPB)	PCE (PPB)	SAMP LOC.	FLOW READING	CASDOM CHANGE	COMMENTS	WELL DEPTH (FT)
** SOLJAK, EDWARD									
SOLJAK, EDWARD	RD#1, BARTO, PA 19504	01/21/87	16	ND	3	-	-	SAMPLES BEFORE SOFTENER SYSTEM	UNK
SOLJAK, EDWARD		02/25/87	24	ND	3	-	-	CRL ANALY, TAT SAMPLING-WELL	
SOLJAK, EDWARD		08/31/87	13	8.4	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	
SOLJAK, EDWARD		01/19/88	27	ND	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	
** STEPHENS, WILLIAM									
STEPHENS, WILLIAM	BOX 175, RD#1, BARTO, PA 19504	12/29/86	ND	ND	3	-	-	TAT SAMPLING-WELL	UNK
STEPHENS, WILLIAM		08/04/87	ND	ND	3	-	-	WASTEX ANALY, TAT SAMPLING-WELL	
** WAGNER, C. HOUSE									
WAGNER, C. HOUSE		03/05/87	ND	ND	1	-	03/05/87	KIRBY ANALY, TAT SAMPLING-TAP	
WAGNER, C. HOUSE		03/05/87	ND	ND	2	-	03/05/87	KIRBY ANALY, TAT SAMPLING-WID	
WAGNER, C. HOUSE		03/05/87	148	7	3	-	03/05/87	KIRBY ANALY, TAT SAMPLING-WELL	
WAGNER, C. HOUSE		08/04/87	877	25	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WAGNER, C. HOUSE		08/31/87	295	23	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WAGNER, C. HOUSE		12/04/87	116	9	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WAGNER, C. HOUSE		01/19/88	892	3	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WAGNER, C. HOUSE		03/03/88	746	18	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
** WAGNER, ROBERT									
WAGNER, ROBERT	BOX 257, RD#1, BARTO, PA 19504	01/21/87	180	2	1	-	-	TAT SAMPLING-TAP	UNK
WAGNER, ROBERT		03/05/87	ND	ND	1	-	03/05/87	KIRBY ANALY, TAT SAMPLING-TAP	
WAGNER, ROBERT		03/05/87	ND	ND	2	-	03/05/87	KIRBY ANALY, TAT SAMPLING-WID	
WAGNER, ROBERT		03/05/87	151	8	3	-	03/05/87	KIRBY ANALY, TAT SAMPLING-WELL	
WAGNER, ROBERT		08/04/87	384	4	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WAGNER, ROBERT		12/04/87	861	10	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WAGNER, ROBERT		01/19/88	1,345	3	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
WAGNER, ROBERT		03/03/88	778	6	1	-	-	WASTEX ANALY, TAT SAMPLING-TAP	
** WETZEL, DONNA									
WETZEL, DONNA	BOX 345, RD#1, BARTO, PA 19504	09/27/83	27	ND	-	-	-	DER SAMPLING AND ANALYSIS	222
WETZEL, DONNA		10/19/83	8	ND	3	-	-	TAT SAMPLING-WELL	
WETZEL, DONNA		10/31/83	27	ND	3	-	-	TAT SAMPLING-WELL	
WETZEL, DONNA		09/18/86	17,000	200	3	-	-	TAT SAMPLING-WELL	
WETZEL, DONNA		11/12/86	22,857	343	3	-	-	TAT SAMPLING-WELL	
WETZEL, DONNA		01/19/87	ND	ND	1	-	01/15/87	FLOW METER INSTALLED 01/20/87	337
WETZEL, DONNA		01/19/87	ND	ND	2	-	01/15/87	KIRBY ANALY, TAT SAMPLING-WID	
WETZEL, DONNA		01/19/87	776	99	3	-	01/15/87	KIRBY ANALY, TAT SAMPLING-WELL	
WETZEL, DONNA		02/24/87	ND	ND	1	-	01/15/87	KIRBY ANALY, TAT SAMPLING-TAP	
WETZEL, DONNA		02/24/87	ND	ND	2	-	01/15/87	KIRBY ANALY, TAT SAMPLING-WID	
WETZEL, DONNA		02/24/87	8300	275	3	-	01/15/87	CAL ANALY, TAT SAMPLING-WELL	
WETZEL, DONNA		04/02/87	ND	ND	1	-	01/15/87	KIRBY ANALY, TAT SAMPLING-TAP	
WETZEL, DONNA		04/02/87	ND	ND	2	-	01/15/87	KIRBY ANALY, TAT SAMPLING-WID	
WETZEL, DONNA		04/02/87	9	36	3	-	01/15/87	KIRBY ANALY, TAT SAMPLING-TAP	

AR100166